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ABSTRACT

This guide is one of a set of 10 science guides, each covering a separate grade in Manitoba, together covering kindergarten through grade 9. The guides have been designed to provide a framework for building scientific concepts and developing the learning of process skills. They replace an earlier set of guides dated 1979. Each guide is essentially the same through the first 16 pages, after which the core units vary appropriately for each academic level. Three themes and units within those themes which are carried through the K-4 program include: (1) environmental interdependency and interaction--adaptions to environment (grade 5); (2) matter and energy--electric charges/ forces and motion/physical and chemical change (grade 5); and (3) earth, time and space--the changing earth (grade 5). Appendices include: (1) K-9 program overview; (2) science processes development: K-9; (3) science processes development: problem solving, K-9; (4) objectives and concepts for STS interactions; (5) K-9 STS content; (6) uses of computers in science; (7) safety in science; (8) women in science; (9) science fairs; (10) basic equipment lists for grades 5-9; (11) directions for using the microscope; and (12) a copy of the response questionnaire for the K-9 program of studies. (KR)

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Manitoba Education and Training

1991

science: grade 5

interim guide

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science: grade 5

interim guide

THIS GUIDE IS SUBJECT TO REVISION ON THE BASIS OF INFORMATION RECEIVED FROM SCHOOLS. IT IS EXPECTED THAT MODIFICATIONS WILL NOT BE MADE IN THE DESIGN OF THE PROGRAM. RATHER, CHANGES MAY BE MADE IN AREAS CONCERNING STRATEGIES AND IMPLEMENTATION.

manitoba education and training

1991

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This guide was prepared by Manitoba Education and Training to provide students with some basic understandings and skills in science. The interim form of this guide has been developed on the basis of feedback from teachers during the period of 1988-89. The 5-9 science program has been designed to articulate with K-4 science and to provide basic concepts and skills which will be useful to students continuing in the sciences. This guide may be used in September, 1991, in place of the previous (1979) guide.

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INTRODUCTION

RATIONALE

The previous science curricula, designed during the period of 1976-78, were concerned with helping students to rationally process data within the context of a scientific knowledge which could sometimes be applied to student and environmental concerns. These emphases occurred because of the apparent needs of the middle years student, the impact of environmental and energy problems upon the aims of science education, and the potential effect of science and technology upon the student and society. Although the specifics may have changed since the 70's, the general needs of the 11-15 year old students and aims of science education which can satisfy these needs remain unchanged. However, the need to review an area of science education with a high impact upon students' future decisions, the increased effect of science and technology upon the individual affecting our need to understand this area, teacher feedback concerning the program, and other items have indicated a need to modify some of the emphases and design of the program.

During the last two years, teacher surveys relative to the K-6 and 7-9 science programs have been conducted. These surveys and a major Science Council report[1] indicated that a general or integrated science program should be retained which had a balance among major ideas that would aid students in applying them to his/her environment; and to provide a flexibility in the design of the program. In addition, the surveys indicated a need to review some of the space, environmental, and physical science units. Because the K-9 science program was reviewed, it was possible to examine the sequence and development of concepts and processes in such areas as the environmental theme. Thus, some units such as the Grade 7 unit on micro-organisms was modified to reflect a greater environmental emphasis.

Newspaper articles and television reports are constantly reminding us of the increasing impact that science-technology has upon humans and their environment. An introduction to the nature, strengths and limitations of science and technology occurs in this curriculum and is applied more fully in the senior years. For example, the science and technology of flight and possibilities of energy conservation are introduced and applied.

Students are bombarded with a tremendous amount of data which is sometimes conflicting and of uncertain validity. Consequently, they need skills to organize and evaluate information, and to apply scientific knowledge to life situations. In order to help students to become scientifically literate in today's society, this curriculum should begin to develop the following attributes:

- Understands scientific concepts and their applications in practical situations.
- Recognizes the strengths and limitations of science and technology and their applications to life management and societal decisions.
- Applies science processes, concepts, and values to problem-solving and responsible decisions.

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[1] Science for Every Student. Science Council of Canada.

- Understands and respects the ethics of science and the relationship of science to other fields of learning.

- Maintains a positive interaction with their environment.

- Develops an interest in science-related skills which can be applied to lifelong learning.

AIMS (GOALS)

GOALS OF THE SCIENCE 5-9 CURRICULUM

In general, today's educational goals emphasize the need to help learners to achieve their potential as responsible individuals. These individuals will have acquired the knowledge and skills for understanding ideas and solving problems; developed respect for others, their cultures, and the environment; and remained an active learner with a productive future. The goals of science education contribute to general learning goals through experiences which help students to understand the nature of science and technology and the ability to apply their knowledge and skills to managing their lives. As a student progresses from Science 5 to Science 9, the following skills, knowledge and attitudes should be acquired:

1) An understanding and facility in applying the skills and processes of science.

   Processes of science include identifying a problem, observing, inferring, formulating models and experimenting. The complete list of processes can be found on page . In addition, an understanding of the nature and limitations of science will be developed.

   The psychomotor skills necessary for proper laboratory techniques and safe handling of equipment and materials are included.

2) A facility in problem solving using science.

   Students will be provided with opportunities to use scientific concepts and processes to define problems and reach conclusions. Some of the skills, which will be developed, include the ability to:

   - Recognize and define a problem, its central issues and assumptions.

   - Develop alternate solutions to a given problem.

   - Evaluate evidence including gathered data, print and non-print information, and the validity of conclusions.

3) The basic knowledge and attitudes* needed to function in a scientific and technological world.

   Concepts are provided in the areas of life-environment, earth-space, and physical sciences. Attitudes, to be developed, include a curiosity and interest in scientific phenomena, questioning of all things, respect for accuracy and precision, belief in cause-effect relationships, and suspension of judgment pending adequate data.

4) An understanding and appreciation of the relationship between science and technology and their relationship to society and the individual.

   Students will have opportunities to develop understandings such as:

* See Attitude and Values, page 3.

- The nature of science as a search for truth, with presently tentative understandings based upon both rational insight and chance discovery.

- The differences between science and technology and their abilities and limitations for solving problems.

- The recognition of potential implications for society of scientific discoveries.

The student is affected personally by the growth of scientific knowledge. The student should become aware of how the knowledge of science enhances personal life management. For example an understanding of such things as properties of matter and radiation, plants and animals, the environment and natural resources, chemical reactions, and appliances and machines will help students enrich and manage their own lives at school and in the future.

5) Respect for the environment and the relationship of science to issues and values.

Students will be provided with opportunities to develop a respect for living things, the nature of their interactions, and the potential effects of human decisions upon the environment. During the upper levels of the curriculum opportunities to use science information and skills to examine and clarify various social and environmental issues will be provided.

6) Awareness of the career opportunities in science and technology.

ATTITUDES AND VALUES

The student should develop positive science attitudes which can be either scientific or environmental in nature.

SCIENTIFIC ATTITUDES

1. Develop a curiosity about natural events that occur on Earth.

2. Become aware of the universe and its contents.

3. Recognize the impact of space research and space technology on communication, weather prediction, and spin-offs.

4. Value the differences that exist between organisms, including humans.

5. Foster an appreciation of technology on society.

6. Develop an awareness of how scientific research and development affect our lives.

7. Develop a concern for energy and the need to conserve energy.

8. Be aware of alternative forms of available energy.

9. Appreciate the impact of chemicals.

10. Develop a concern for safety in the home and school.

11. Deal with problems in an open-minded manner.

12. Use scientific knowledge and skills to clarify personal values.

ENVIRONMENTAL ATTITUDES

1. Appreciate the environment and the interactions of life forms within the environment.
2. Develop an awareness of threats to the environment such as greenhouse effect, acid rain and pollution.
3. Distinguish between the proper use and the misuse of chemicals on the environment.
4. Develop a responsible attitude towards managing and conserving the environment.

LEARNING THEORY AND PROGRAM DESIGN

The Science 5-9 program attempts to consider present knowledge of the intellectual and social development of middle years students and the nature of science education in designing the program. As illustrated in the aims, science education is concerned with helping students to apply concepts to their interpretation and management of their world. In the past, much has been written about intellectual development from the stage of focusing on the particular and concrete to the formal operational stage[2]. Although science education research has maintained its interest in developmental ideas, recent research has also been concerned with the efforts of students' preconceptions about the real world upon their understanding of the world as defined scientifically. A current perspective of learning maintains the view that learning is an active process with the following concepts[3].

- Students' conceptions, purposes and motivations influence the way in which they interact with learning materials in various ways. Those commonly held concepts of systems which are different from the scientific reality are called misconceptions.[4] For example, a common misconception about current electricity is that current is used up as it flows around a circuit.

- Learning involves constructing meaning as a continuous and active process. Although the meanings may appear to be incoherent to others, the student may not see the idea as incoherent. For example many young children believe that an object sinks more readily in deeper water.

- Meanings are stable; modification of a meaning is dependent upon a student's belief. Although students may be able to develop a new idea which conflicts with old, they are often reluctant to accept it and develop a new system of thinking. For example, some students in physics tend to associate constant force with constant motion and have difficulty in accepting that tables and walls, in static equilibrium, can exert forces.

[2] Osborne K. Middle Year Sourcebook: Some Suggestions for the Education of Early Adolescents. Department of Education, Province of Manitoba, 1984.

[3] Driver, R. and Bell, B. "Students' Thinking and the Learning of Science: A Constructivist View", School Science Review, March, 1986, p. 443, 456.

[4] Eaton, J. F., Anderson, C. W., Smith, E. L. "What Students Don't Know. They Don't Know", Science and Children, April, 1983, p. 7-9.

- Some meanings are shared i.e. commonly held ideas can be identified. For example, research indicates that children have a tendency to identify heat with temperature and to consider heat as having fluid properties. Heat transfer is better understood when a temperature change occurs (conduction) than when it does not (change of state)[5]. In regard to plant nutrition, many students associate food getting with the soil and have little understanding of the relationship between photosynthesis and other physical and chemical processes[6]. After all don't we say "Give that carnation some plant food?"[6]

The above learning assumptions and research findings have a number of implications for the design and teaching of science.

IMPLICATIONS OF LEARNING THEORY TO THE DESIGN AND TEACHING OF THE SCIENCE PROGRAM

Learning theory has been related to the design of the Science 5-9 program and teaching strategies in the following ways:

- The program design has attempted to provide a developmental sequence of tasks and skills whereby students are required to process data and variables. An increase in the complexity of the variables which are considered and the degree of student input or control is increased e.g. the testing of a consumer product or of a hypothesis.

- Variation among students is considered within the program design in two ways. Firstly, the program provides suggestions for a wide range of activities. Secondly, the design has been modified in order to provide additional time. The time is critical for encouraging students to hypothesize and generate models, test assumptions, and to explore concepts with others.

- A need exists to apply concepts in a variety of real-world or practical situations. For example, many students believe that steel and wood in a room are at different temperatures. Students should examine heat transfer and temperature with a variety of materials. The science-technology-societal theme encourages application in topics such as flight or the design of models.

- Language development correlates highly with the development of reasoning skills according to a number of research studies. Teachers should consider the following activities to support the development.

  a) Incorporate reporting tasks where connective terms such as "since, hence, similarly" are required to summarize results.

  b) Use examples that require formal reasoning with concrete situations.

  c) Provide practice in visualizing and verbalizing concepts and ideas.

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[5] Brook, A. et al. Aspects of Secondary Students' Understanding of Heat. Centre for Studies in Science and Mathematics Education, The University of Leeds, 1984.

[6] Bell, B. et al. Plant Nutrition. Centre for Studies in Science and Mathematics, University of Leeds, 1985.

- Since students are developing more sophisticated understandings over time, the curriculum design has included aspects of a spiral curriculum within some of the themes.

- Pupil interaction with concrete situations requires that teachers spend the necessary class time getting students to make sense of their experiences and by helping them connect activities to past and future science knowledge. This can be supported by determining students' ideas (including misconceptions) early in a unit creating situations whereby they must clarify their ideas, evaluate alternatives, and apply them in a range of situations. This can be achieved by focusing on the processes rather than on the content of science.

SELECTION AND USE OF CURRICULUM MATERIALS

In this revised course, the curriculum consists of the objectives of each unit as listed in the expanded outline. The materials presently in the schools as well as the materials which will be recommended on an ongoing basis by the Department of Education and Training are to be used by students and teachers to develop the concepts or skills specified in the objectives. Teachers are encouraged to seek out additional materials which will provide them with assistance in planning their lessons.

GENERAL PROGRAM OVERVIEW AND ESTIMATED TIME ALLOTMENTS

THEMES	5	6	7	8	9
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION	Adaptations to Environment	Interactions of Populations with Environment	Microbes and Ecosytems (22)	Cells and Organ Systems (24) --- Plants and the Environment	Reproduction and Heredity (18) --- Plant and Animal Interactions (24)
CHANGES IN MATTER AND ENERGY	Electric Charges --- Force and Motion --- Physical and Chemical Changes	Force and Motion --- Machines ---	Light (22) --- Physical Properties (16) --- Physical Changes of Matter	Heat (22) --- Alternative Energy Forms (16) --- Flight (22)	Force, Work and Motion (18) --- Chemical Interactions (18)
EARTH, SPACE AND TIME	Changing Earth	Weather --- Earth in Space	Rocks, Minerals and Soils (24) --- The Observable Universe (16)		The Changing Earth's Crust (22)

NOTE: Grades 5 and 6: Recommended 30 minutes per day for science. Units are of approximate equal length.
Grades 7, 8 and 9: Estimated time (hours) per unit.

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
INTER-DEPENDENCY AND INTERACTION	LIVING AND NON-LIVING . characteristics . plants as living organisms, growth needs	ANIMALS . animal characteristics . comparison of different animal properties . animal care OURSELVES . variations and comparisons among people characteristics	ORGANISMS IN THE ENVIRONMENT . properties unique to six animal groups (insect, birds, mammals...) . properties of deciduous trees and plant needs . organisms - response to stimuli . animal-plant characteristics and habitats . man's interactions	LIFE CYCLES . complete and incomplete metamorphosis . animal behaviour and instinct	POPULATION INTERACTIONS . nature of a population and habitat . animal interdependency herbivores, carnivores, omnivores, and predator-prey . food recycling, food chain and web . population - environment interactions . human interactions

SCOPE AND SEQUENCE

THEMES	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
INTER-DEPENDENCY AND INTERACTION	ADAPTATIONS TO THE ENVIRONMENT . structural and behavioural adaptations (plants and animals) . Adaptations related to distribution, reproduction and survival	INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT . populations needs and competition . Producers and consumers . Human dependency and interaction with environment	ENVIRONMENT . ecosytems-interaction of biotic and abiotic factors . yeast is a decomposer . Factors affecting population growth in a yeast culture . microorganisms - benefits and harm	ENVIRONMENT . factors involved in photosynthetic process . growth and soil . plant respiration . plant role in environment and with man CELLS AND ORGAN SYSTEMS . organization - cell to system . structure and function - circulatory and respiratory systems . Health problems and solutions	INTERACTIONS . interactions-competiton to commensalism . energy changes in food chains to pyramids . Nature of succession . Management REPRODUCTION AND HEREDITY . asexual and sexual cellular reproduction . human reproductive system, structure and cycles . variations in human traits . genetic control and prediction

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
MATTER AND ENERGY	PROPERTIES OF OBJECTS . senses help determine properties of objects (size, colour, shape, texture, hardness, weight) . classification and identification from properties . change in properties	PROPERTIES OF MATTER . materials have unique properties, can identify . characteristics of solids and liquids . changes in solids' properties (dissolved, heated) . patterns and order in change	FLOATING AND SINKING . objects vary in ways they float . different liquids and shape affect an object's floatation . depth of a liquid has no effect . designs of objects can be tested for floatation	CHANGES IN MATTER . matter made of parts . particles in liquids and gases . separation in mixtures . liquids vary in properties . nature of physical change AIR AND AIR PRESSURE . properties of air . warm air rises . air contains water vapour HEAT AND TEMPERATURE . heat energy causes motion . expansion and contraction . temperature measurement . conductors and insulators . absorption - colour	SOUND . sound caused by vibrations, pitch . sound travel - direction, loudness . sound conductivity . sound pollution and control STRUCTURES . cell structure and characteristics . skin and skeletal structures - materials, size and strength . size, shape design and materials affect a structure's strength ELECTRICITY . single cell circuit and switch . several cells circuit (one bulb) . series and parallel circuit . conductors, insulators and the light bulb

SCOPE AND SEQUENCE

THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
MATTER AND ENERGY	CHEMICAL AND PHYSICAL CHANGE . properties identify objects . characteristics of physical change (shape, size, state mixtures) . chemical change characteristics ELECTRIC CHARGES . static electricity - nature and production . electric current - chemical production, electro magnetism, applications FORCE AND MOTION . unbalanced forces on motion . weighing objects - balance beam and spring scale . transmission of forces and test of strength	FORCES AND MOTION . force on an area . factors affecting floatation and design of floating objects FORCE AND MACHINES . effort and resistance relationships (six simple machines) . lever, inclined plane and pulleys relationships are quantitative . complex machines contain two or more simple machines	PHYSICAL PROPERITIES . changes in state, water cycle . fusion, vapourization and temperature . factors affecting solutions and separation . properties of industrial products, testing LIGHT . transformation of light energy . light transmission - reflection and refraction . light and colour . uses of lens	HEAT . heat and temperature . energy transformations to heat . heat transfer and applications . expansion, contraction and applications . alternative sources ALTERNATIVE FORMS OF ENERGY . formation or production of fossil, solar, nuclear, wind, and hydro-electric energy . cost-benefits of alternatives FLIGHT . factors affecting . lighter-than-air flight . forces and controls on heavier-than-air flight . design factors . navigation in space	CHEMICAL COMPOSITION AND CHANGE . characteristics of chemical change . elements, atoms, compounds and reactions . conservation of matter . acids and bases, characteristics and tests . household chemistry and safety FORCE-WORK MOTION . unbalanced forces, gravity . quantitative relationships within simple machines . mechanical advantage, work and efficiency . friction effect on efficiency

SCOPE AND SEQUENCE

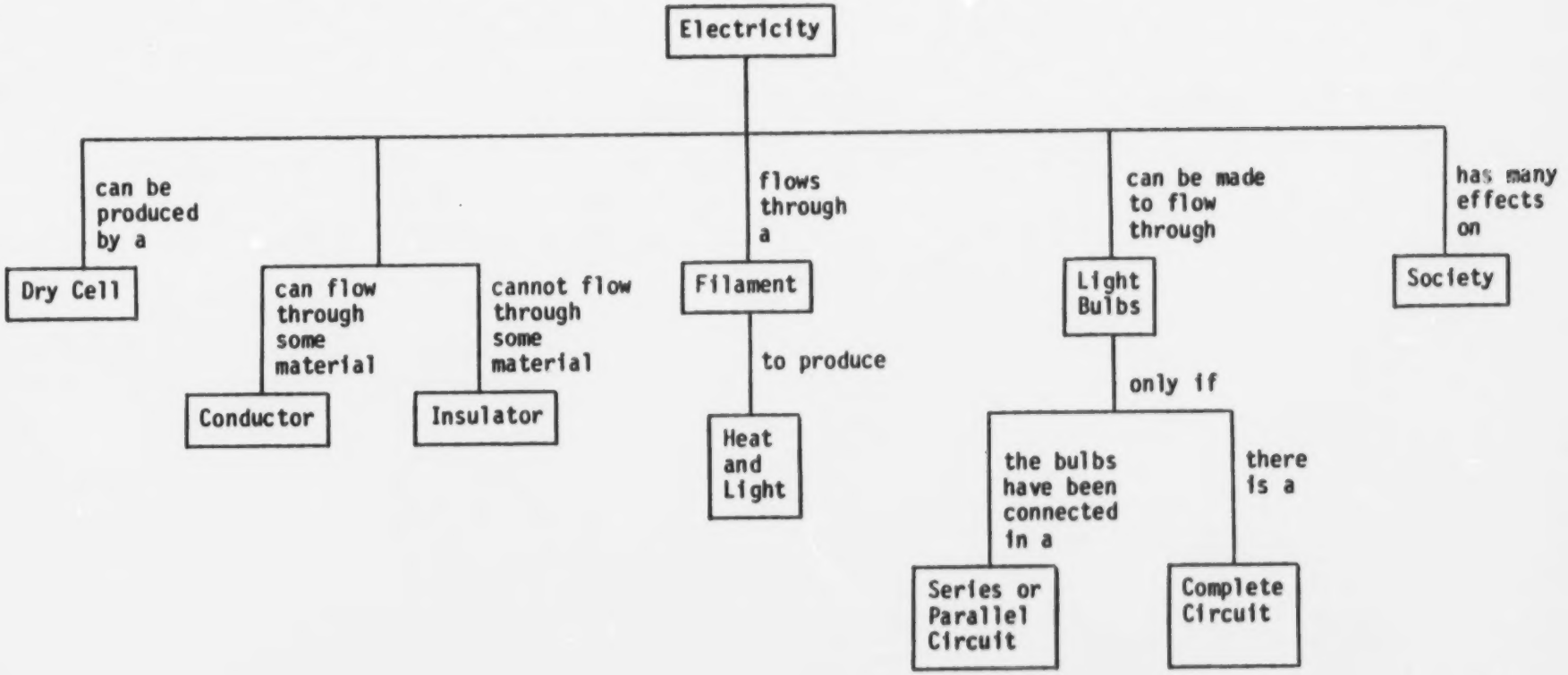
THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
EARTH, TIME AND SPACE	SIZE, POSITION AND TIME . size comparisons (non-standard units) . reference points and position . ordering of events	COMPARING AND MEASURING EVENTS . regular and irregular events . events in time sequence . time measurement (non-standard and standard units)	MEASURING TIME AND POSITION . time measurement - standard units . size and distance - standard units . position location measurement LIGHT AND SHADOWS . light position and size, nature of shadows	SUN, EARTH AND MOON . light reflection and conduction . sun - object shadows . relative position - night and day, moon phases THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space	WATER AND LAND . erosive effects of water . factors effecting erosion . absorption of water into land . water cycle . conservation

SCOPE AND SEQUENCE

THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
EARTH, TIME AND SPACE	CHANGING EARTH . rocks and minerals . sedimentary rock formation . fossil formation	EARTH IN SPACE . rotation and time . revolution and seasons . planets in the solar system . technology for observation WEATHER . factors affecting air movement . humidity, air movement relates to cloud formation and precipitation . weather and air masses, prediction and technology	ROCKS, MINERALS AND SOILS . igneous, sedimentary and metamorphic rocks . the rock cycle . testing of minerals . uses of rocks and minerals . nature and production of soil . erosion and soil management THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics, and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space		THE CHANGING EARTH'S CRUST . Alternate theories for continental structure . evidence for plate tectonics theory . technological support . relationship of plates to volcanoes, earthquakes and mountains

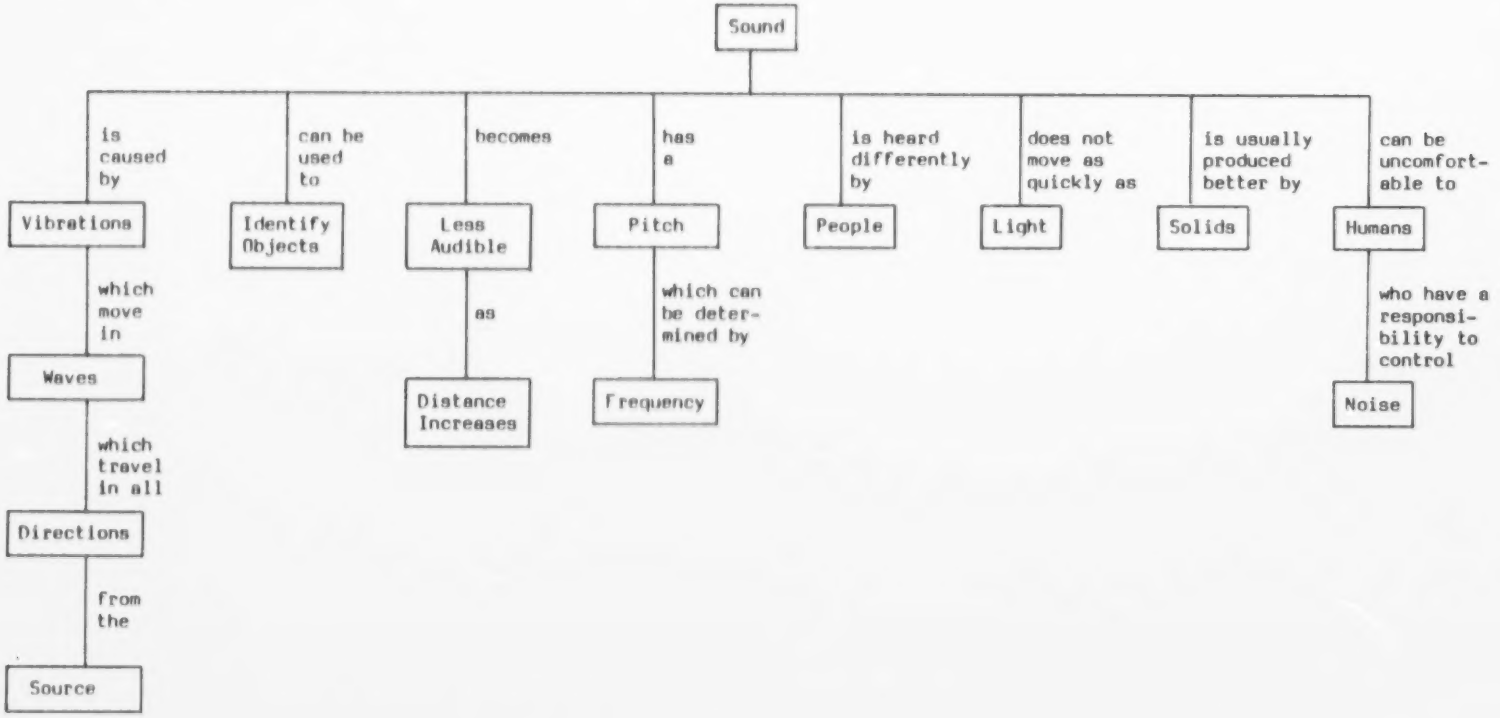
GRADE FOUR

CHANGES IN MATTER AND ENERGY: ELECTRICITY



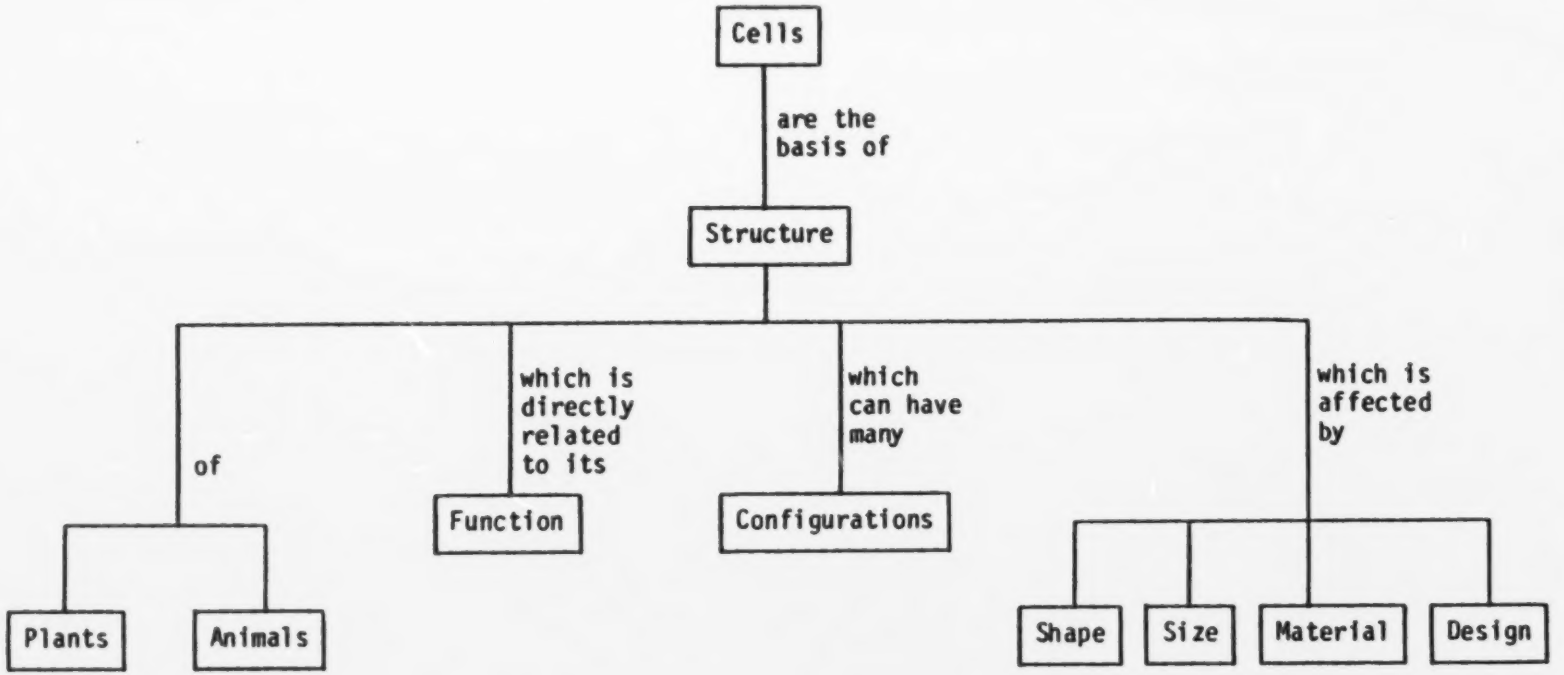
GRADE FOUR

CHANGES IN MATTER AND ENERGY: SOUND



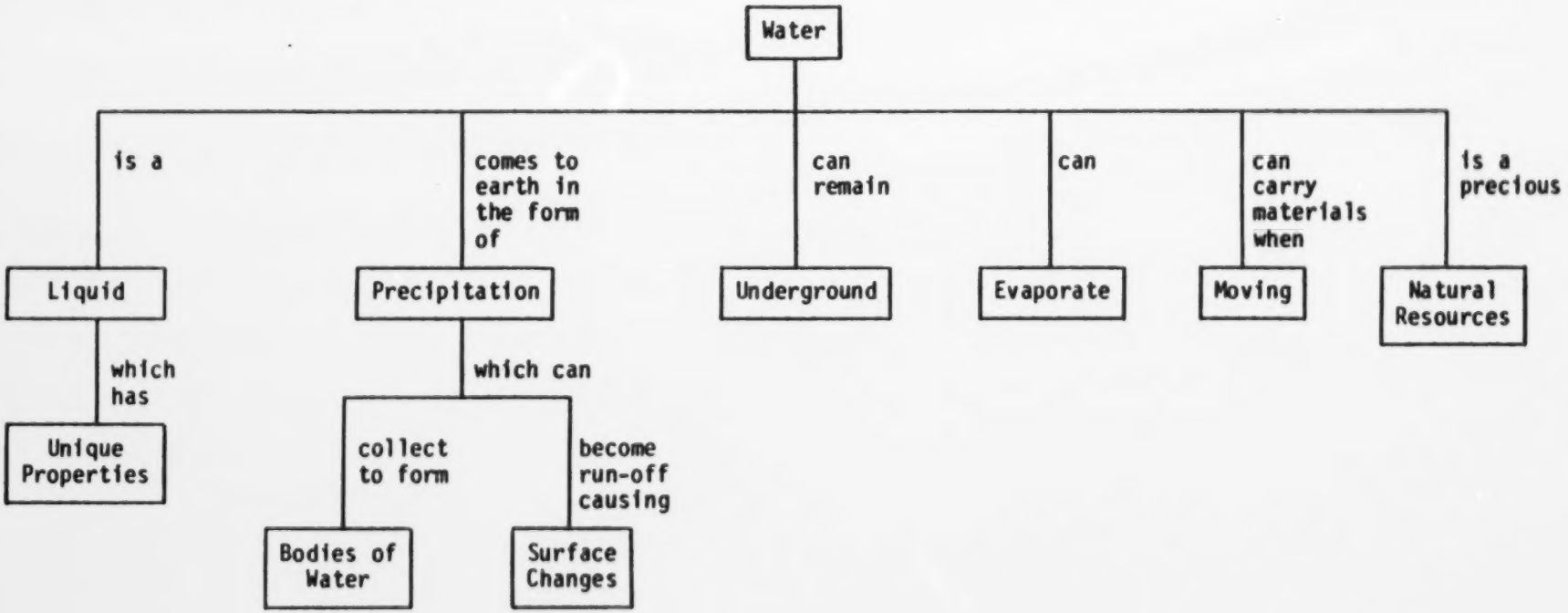
GRADE FOUR

CHANGES IN MATTER AND ENERGY: STRUCTURES AND FUNCTIONS



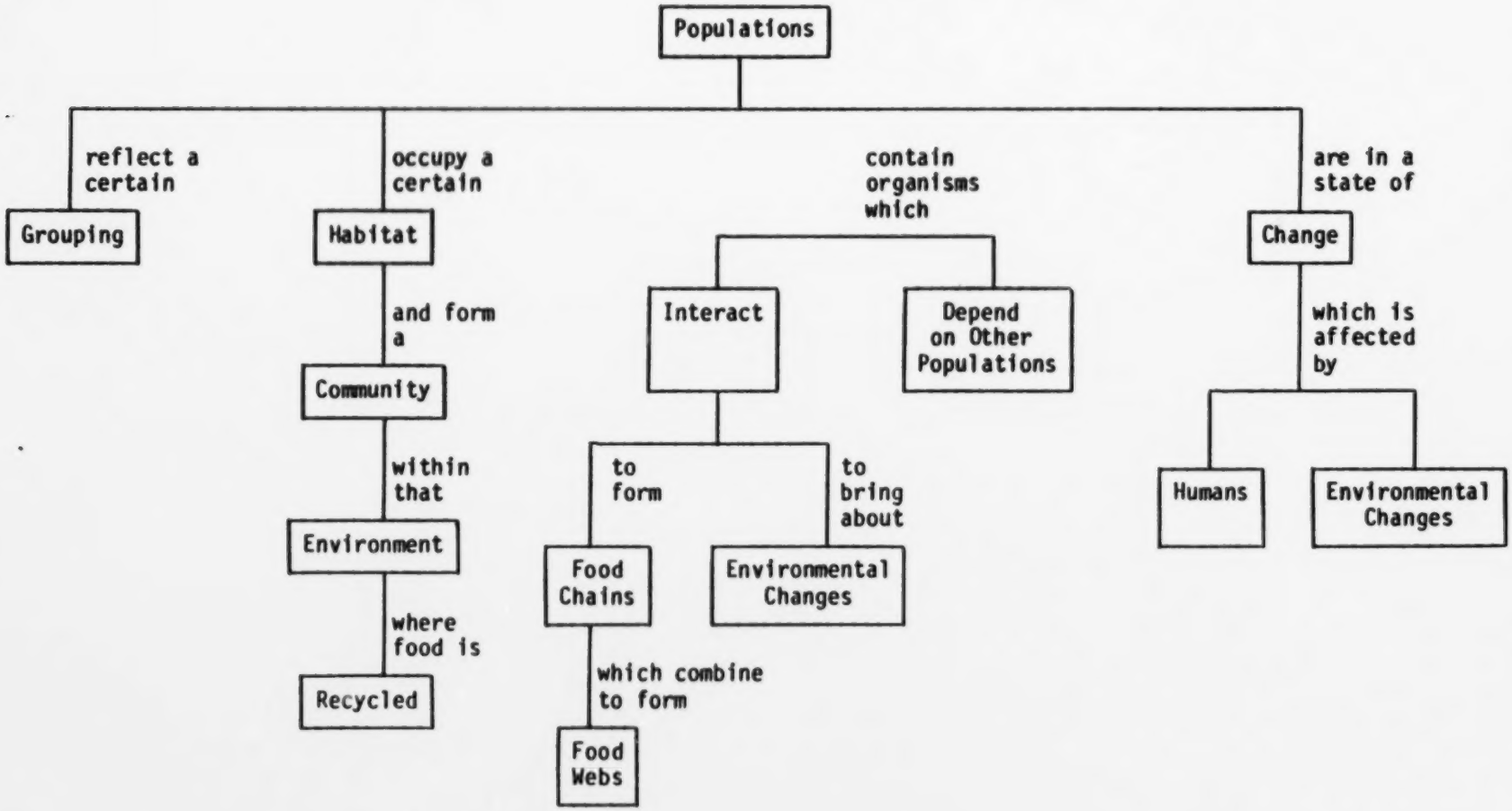
GRADE FOUR

EARTH, SPACE AND TIME: WATER AND LAND



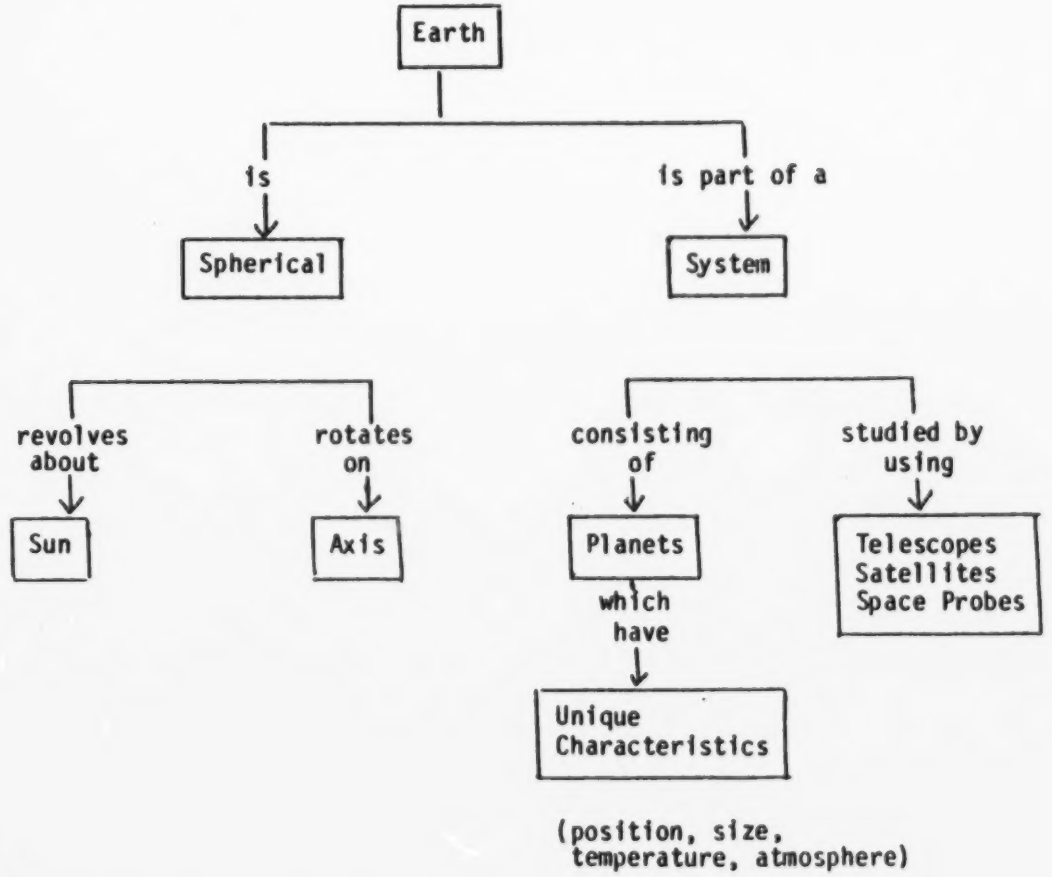
GRADE FOUR

INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: POPULATION INTERACTIONS



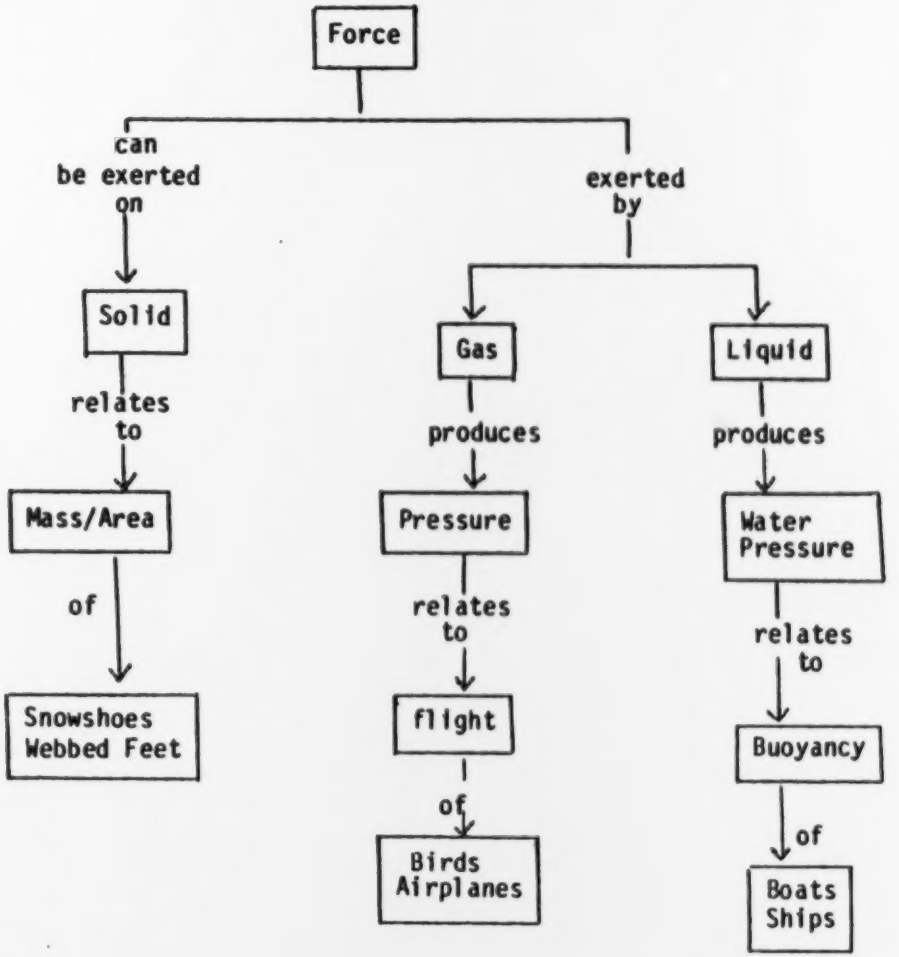
GRADE 6: EARTH SPACE AND TIME: THE EARTH AND THE SOLAR SYSTEM

EARTH AND THE SOLAR SYSTEM

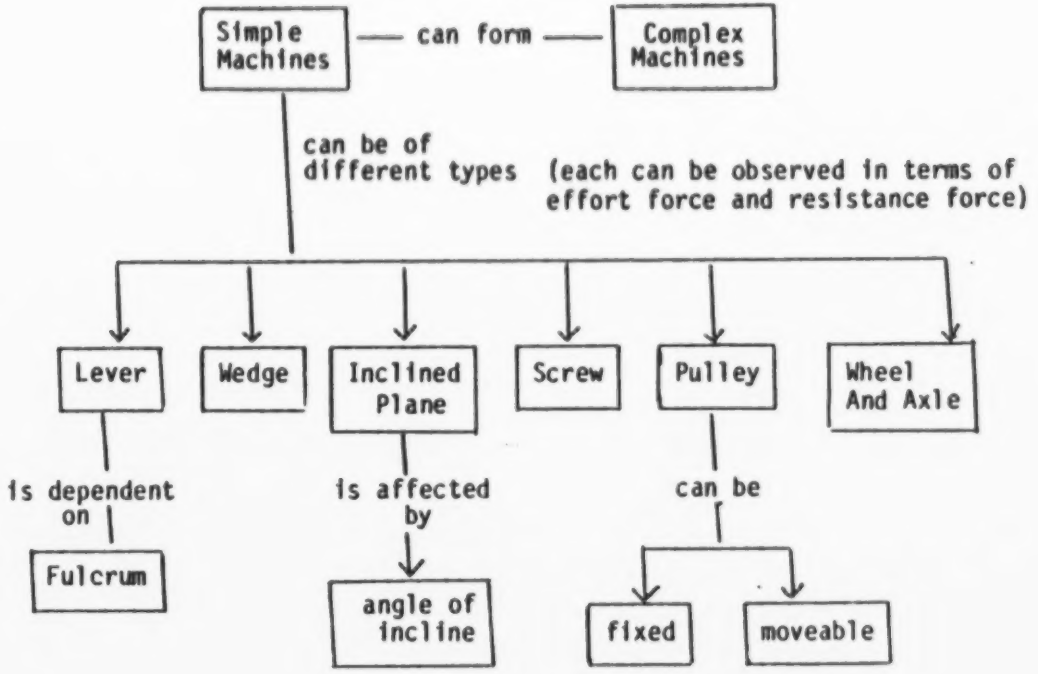


GRADE 6

CHANGES IN MATTER AND ENERGY: FORCES AND MOTION

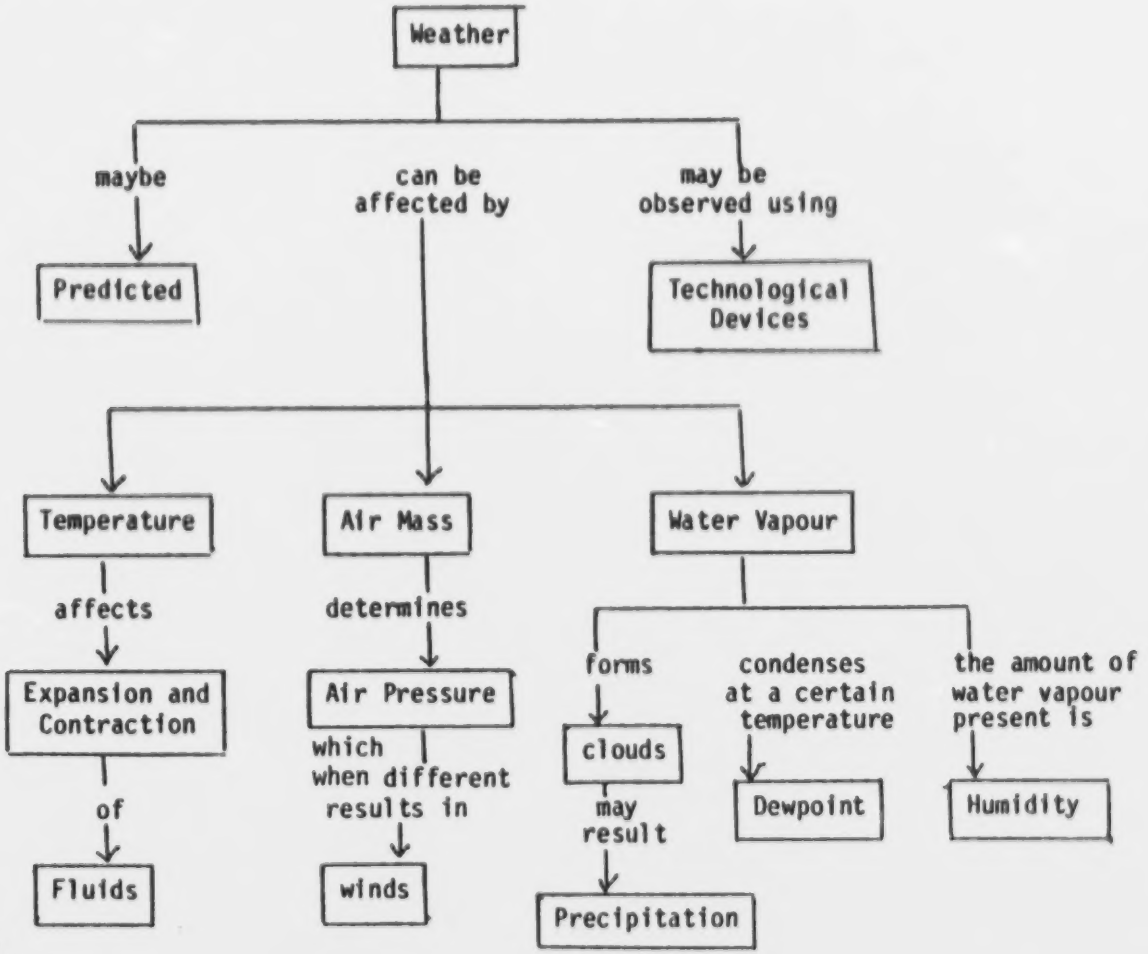


GRADE 6: CHANGES IN MATTER AND ENERGY: SIMPLE MACHINES



GRADE 6: EARTH, SPACE AND TIME: WEATHER

WEATHER



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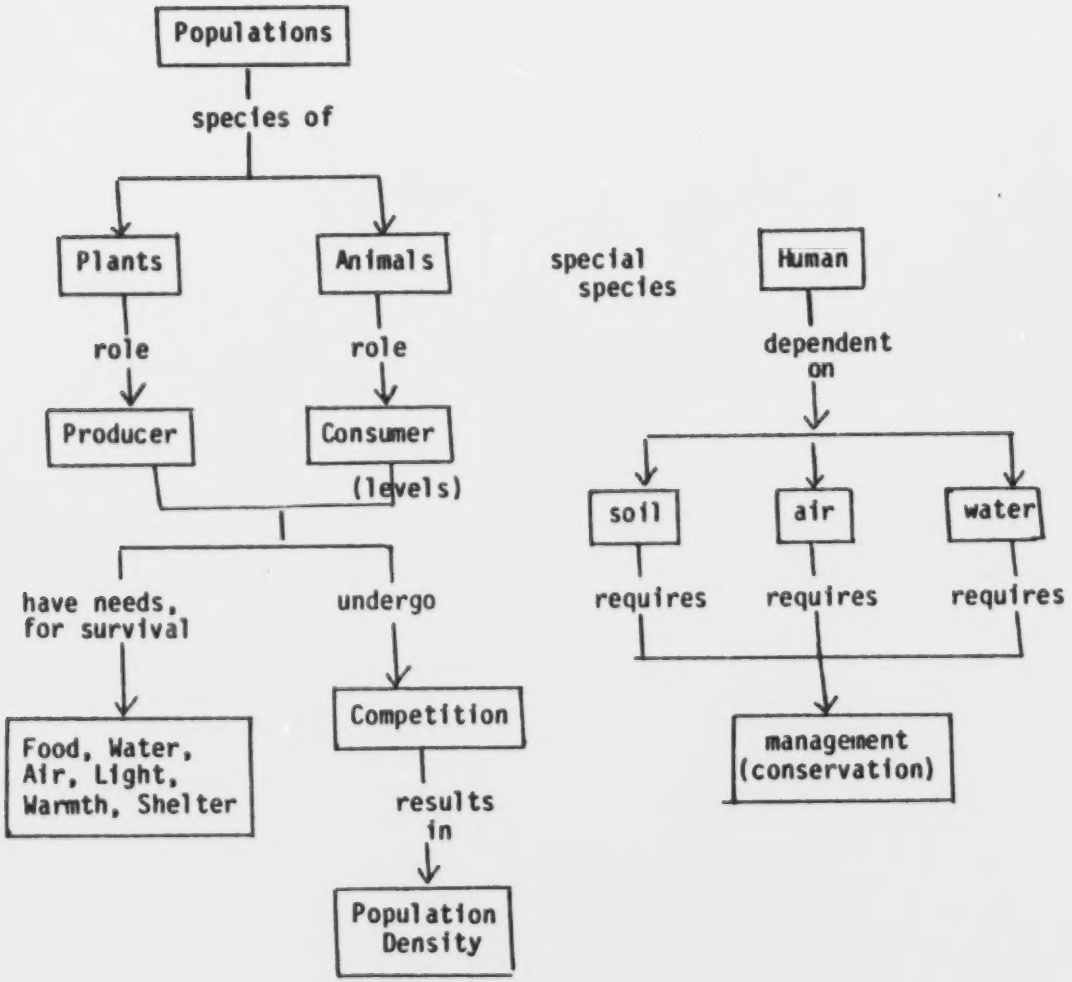
GRADE 6: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT



PROCESSES OF SCIENCE

Inquiry in science can be represented by specific intellectual skills entitled "processes." Processes are identifiable behaviours, used by scientists which can be generalized across content domains. These behaviors contribute to rational thinking in everyday affairs. In order to become an increasingly active and dynamic investigator of science the student needs to use the processes of the scientist. Through conscious, systematic development of these processes, the student will become increasingly better equipped for more complex learning in the fields of science as well as other areas of investigation.

Observing

Observing is one of the basic process skills of science. It involves obtaining information about objects, situations or events using the five senses. Observations may be qualitative or quantitative in nature. Observing provides both a basis for new inferences or hypotheses and a tool for testing existing inferences and hypotheses.

Measuring

Observations are quantified using non-standard and then standard units. Length, area, volume, mass, time intervals and force are among the measurements which are used. Appropriate measurement instruments and units within the metric system are selected. Examples of measurement include "using paper clips as standard units for measuring an object," "calibrating a scale," and "measuring the rate of hatching organisms."

Classifying

Classifying is the grouping of objects, concepts or events on the basis of some observable properties in order to show similarities, differences and/or interrelationships.

Inferring

Inferring means suggesting more about a set of conditions than is observed. Inferences are based upon observed data and past experience. This may evolve from both direct and indirect evidence and are modified on the basis of new evidence. Examples of inference include "inferring the identity of objects on the basis of observing their shadows" and "inferring the kind of material (chemical) on the basis of evidence obtained from tests."

Predicting

A forecast is made about future events on the basis of ordered data. Predictions on the basis of ordered data, extrapolation beyond an observed pattern of events, and tests of predictions can be made. Examples of prediction include "predicting the appearances of adults that will grow from young animals" and "predicting the consequences of changes in an animal habitat."

Organizing and Processing Data (Communicating)

Organizing and processing data is a process that occurs between the observation stage and the interpretation or generalization stage. It usually involves the organization of "rough" data into a more compact and meaningful way (ordering, rearranging, comparing), depicting the data pictorically or graphically, and processing data mathematically (finding slopes, tangents, etc.) in order to facilitate interpretations.

Recognizing and Identifying a Problem

This process involves recognizing and focusing on problems that can be investigated. It also includes making assumptions about possible variables and the ability to delimit (narrow down) the question under investigation in order that one can proceed to work towards a solution or the ability to formulate and express relevant questions regarding living things, objects and physical events; and general relationships.

Identifying and Controlling Variables

Identifying and controlling variables involves the process of deciding which variables or factors will influence the outcome of an experiment, situation or event, and deliberately controlling all recognized variables in a systematic manner. That is, the independent (manipulated) variable is changed in a systematic way, corresponding changes in the dependent (responding) variable are observed and measured, and all other variables are held constant (controlled). This combination of relationships is referred to as a system. Examples of systems and related variables are a pendulum system where time of a swing is affected by length of the pendulum or an index card is moved a certain distance by the impact of a marble rolling down an inclined plane.

Hypothesizing

Hypothesizing is an "educated guess" about an expected relationship between two variables in an attempt to explain a cause and effect relationship. Hypotheses are based on observations or inferences about a set of events. A hypothesis should be testable; e.g., plants require light for growth.

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Designing an Experiment

Experimenting is a cause and effect test between two variables. All processes may be involved. This can begin with setting a problem to be solved, identifying the variables to be controlled, making operational definitions, devising the test to be carried out and to follow the prescribed procedure.

Interpreting Data

Interpreting is the process by which sense is made out of the observations in the form of inferences, generalizations, or explanations: the generalizations are often a relationship between the independent (manipulated) and dependent (responding) variables. It usually is a direct response to the problem under investigation and, therefore, includes judgements about the interpretation, to fit with proposed hypotheses, and the limitation of the new knowledge. The explanation or generalization thus generated adds to the student's "body of knowledge" in science.

Defining Operationally

A process whereby objects or events are defined in a way which can be observed, used, or tested; e.g., the candle is out when a puff of smoke appears, or hot meaens any temperature over 60 degrees Celsius.

Formulating Models

This process involves the use of physical or mental models while describing the behaviour of something that is unfamiliar in terms of something whose behaviour is familiar. Constant vigilance is necessary to ascertain the validity (fit) of the model or analogy with the phenomenon modeled. Models often have to be revised in order to accommodate both old and new facts.

SCIENCE PROCESSES DEVELOPMENT

SCIENCE PROCESSES	GRADE 5	6	7	8	9
1. Recognizing and Identifying a Problem					
1.1 Recognize patterns and events	D				
1.2 Delimiting and phrasing a problem	D			E	
1.3 Identifying relevant and irrelevant information	D				
2. Observing					
2.1 Use of the senses	D				
2.2 Use of tools to assist observations	D				
3. Measuring					
3.1 Use of instruments with precision	D				
3.2 Construction of simple measuring devices (scales, hygrometers)	I	D			
3.3 Verifying the accuracy of measuring devices	I				
4. Classifying					
4.1 Comparing materials or data	D				
4.2 Classifying and ordering based on a set of keys and criteria	D				
5. Inferring					
5.1 Generalizing data	D				
5.2 Determining adequacy of data as a basis for inferences	D				
5.3 Inferring relationships				I	D
6. Communicating					
6.1 Use of traditional methods (drawing, graphs)	D				
6.2 Mathematical treatment of data				I	D
6.3 Use of non-traditional or technological devices (tapes, discs, pictures)	D				

NOTE: Code - I - Introduced
D - Developed
E - Extend process - Student controlled and directed.

SCIENCE PROCESSES	GRADE 5	6	7	8	9
7. Predicting					
7.1 Identifying and testing prediction	D	----------	----------	----------	----------
7.2 Predicting quantitatively based on interpolation and extrapolation	D	----------	----------	----------	----------
7.3 Predicting based on application of mathematical formula					I
8. Controlling Variables					
8.1 Identify relevant variables	D	----------	----------	----------	----------
8.2 Identify the control variables				I	D
9. Hypothesizing					
9.1 Evaluate existing information	D	----------	----------	----------	----------
9.2 Correctly state a hypothesis	D	--------	E	----------	
10. Interpreting Data					
10.1 Recognize valid interpretations	D	----------	----------	----------	----------
10.2 Recognize limits of interpretations (staying within the data)	D	----------	----------	----------	----------
10.3 Offer alternative explanations				I	D
11. Define Operationally					
11.1 Construct simple definitions based on experiences	D	----------	----------	----------	----------
11.2 Use mathematical as well as verbal definitions				I	D
12. Designing an Experiment					
12.1 Select appropriate techniques	I	D	----------	----------	----------
12.2 Select appropriate techniques for observation and measurement	I	D	----------	----------	----------
12.3 Select appropriate techniques for recording of data	I	D	----------	----------	----------

NOTE: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

SCIENCE PROCESSES	GRADE	5	6	7	8	9
13. Formulating Models						
13.1 Generate spatial models		I	D----------			
13.2 Generate mathematical models						I
13.3 Critically examine models						I

Note: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

PROBLEM SOLVING AND SCIENCE, TECHNOLOGY AND SOCIETY

To prepare a student's facility in problem solving is a goal, which is generally found among today's curricula statements. Mathematics develops skills in analyzing quantitative data and spatial relationships as tools in problem solving; social studies promotes an understanding of documental evidence and the role of values in examining social problems; and technical-vocational studies provide opportunities to solve design and practical problems. Science education, when developing scientific processes and using inquiry within a scientific context, is emphasizing a problem solving approach.

Problem solving is sometimes considered to be the solution to a word problem whereby an obvious algorithm is available to the learner e.g. a type problem. Although this interpretation of problem solving may be useful in the development and application of certain concepts, for our purposes, problem solving is defined as a process whereby a student defines and seeks a solution to a recognized problem. As such, it is more open, a process of exploration and discovery, and the development and use of skills of experimentation and testing. Although no single method exists relative to the development of problem solving skills, the following skills[6] are generally accepted in many problem solving models:

- defining the problem in a resolvable form;
- obtaining data;
- organizing data;
- analyzing data;
- generalizing and synthesizing the data;
- decision making.

[6] Good, R. and Smith, M. "How do We Make Students Better Problems Solvers": Science Teacher, April, 1987, p.p. 31-6.

This general model can be applied in a variety of situations within the science program.

The nature of science-technology and its interaction with society offers a variety of opportunities for incorporating the goal of problem solving. The following examples indicate some possibilities:

- The nature of science can be initially illustrated with younger children by using investigations with magnets or batteries and bulbs to develop process skills. With older students, the development of an understanding of the appropriateness or uncertainty of data and strategies of inquiry are an important part of problem solving.

- The nature of technology and its interaction with ourselves provides a number of opportunities for developing problem solving skills. One possibility is that of resolving problems in the consumer area such as determining the best cleaning product or fabric.[7] Designing and testing of potential technological solutions offers additional possibilities. For example, students could work with the problem of designing a simple bridge using a limited number of straws and testing its strength or constructing and testing the effectiveness of a solar cooker.[8]

[7] The University of the State of New York. Technology Education: Introduction to Technology; The State Education Department, Albany, N. Y., 1987.

[8] McGregor Ann and Scott. Bridges: A Project Book Lothrop, Lee and Shephard Books, N.Y., 1980. Householder, D.L. and Marshall J. "An Introduction to Solar Energy "Industrial Education, September 1984.

SCIENCE, TECHNOLOGY AND SOCIETY

It is useful to consider science and technology as specialized and related problem solving processes. Science is the process that may be used to attempt to answer questions and provide knowledge about the universe and living things and materials in it. Technology is the process by which products and systems are developed to satisfy recognized needs. To design and make these products or systems, the findings of science are used. A Science, Technology and Society (STS) emphasis in the science program attempts to help students understand the applications of science and how this related to the world around them, making science more relevant.

For example, the given concept might be: a technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process. The program's objective would be: the student should be able to explain why some processes become obsolete. The activity would provide the student with the means by which the objective can be achieved.

Each STS activity in the 5-9 science program has been identified with two asterisks (**) beside it. Teachers are encouraged to find or develop other examples.

SUSTAINABLE DEVELOPMENT STRATEGIES

Sustainable development is the process of maintaining our natural heritage. It is important that students are made aware of the need for judicial use and management of our natural resources. The students are the stakeholders. They need to be informed about environmental concerns and the economic devastation which occurs due to a lack of environmental protection.

A Sustainable Development Strategies (SDS) emphasis in the science program will allow students to identify the areas in which environmental damage is taking place and to explore methods by which the environment can be protected. This SDS emphasis begins in kindergarten and continues throughout the entire science curriculum.

Some units lend themselves more to SDS activities and discussions than others. Teachers are encouraged to develop and foster SDS awareness whenever the opportunity arises.

This guide identifies the SDS related objectives with three asterisks (***) beside them.

5-9 PROGRAM OBJECTIVES: SCIENCE, TECHNOLOGY AND SOCIETY

OBJECTIVES	5	6	7	8	9
Students will be able to distinguish between science and technology	X	X	X	X	X
Identify scientific principles upon which a simple technology is based	X	X	X	X	X
Identify examples of interdependence of science and technology		X	X	X	X
Identify components of a functioning technological system with inputs, outputs, feedback, control	X	X	X	X	X
Describe how technological processes or devices are related to one another	X	X	X	X	X
Explain how technology extends the abilities of human beings	X	X	X	X	X
Explain why a technological process or device becomes absolute		X	X	X	X
Demonstrate how science, technology and society interrelate		X	X	X	X
Demonstrate that technology has improved standard of living	X	X	X	X	X
List examples of the impact of technology on jobs and careers			X	X	X
Recognize that science and technology alone cannot solve society's problems			X	X	X
Demonstrate that processes and devices are developed in response to needs	X	X	X	X	X
Demonstrate that certain processes or devices are not accepted because of attitudes		X		X	X
Report on the need for funds to support R & D				X	X
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

OBJECTIVES	5	6	7	8	9
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

NOTE: Refer to Appendix "E" for information on K-9 content: S.T.S.

IMPLEMENTATION: THE PRINCIPAL'S ROLE AND PROGRAM EVALUATION

Within a school board's plans for program evaluation and implementation, the principal of a school has an important leadership role. This role includes the following activities:

- Encouraging a shared management plan of implementation for the science program by providing opportunities for cooperative planning.
- Monitoring the degree of implementation and staff needs.
- Determining the implications of the curriculum for staff training and facilities.
- Providing easy access to the materials and facilities needed for the program.

Program Design Implications

- Like the former design, the new science program is based on the assumption that a general science approach is more applicable to middle years students than a discipline-centred approach. The emphasis on the development of basic concepts and processes has been retained; however, a greater emphasis has been placed on problem solving and the relationship between science, technology and society. The program design implies that teachers of science should have a broad background in the sciences and endorse the interaction of science with the other areas of study.

- The number of units per year have been decreased from the previous program in order to enable schools to increase the emphasis upon science, technology and problem solving; however, new units such as flight, microsystems, and the changing earth's crust may require specific kinds of in-service support.

- Units such as reproduction and heredity (IX) and plant and animal interactions (IX) provide possibilities for integration with other areas of study. Provision of a plan for coordinating staff efforts would be important.

- The program is based upon the premise that schools have sufficient equipment and materials to carry out the necessary activities. Provision of necessary equipment and facilities is critical and a source of funds should be available whereby teachers can easily obtain materials locally.

- Materials will be developed and recommended to support the program. However, schools should continue to search for additional materials which may suggest different teaching emphases and offer different reading levels and student activities.

- The system of measurement used in science courses is SI. By the end of Grade 8, students should know basic SI units in length, area, volume, mass, and speed, simple conversions such as mL to L and familiarity with the newton and joule. Maintaining an emphasis upon the use of these units in the sciences, as well as related disciplines, is necessary.

Program Evaluation

Evaluating the effectiveness of the science program and cooperatively, with teachers, determining methods of achieving the important curriculum objectives is a critical role of leadership. Many sources of data and approaches can be used, such as:

- Evaluation of student achievement and analysis of the methods of evaluation.
- Determining needed teaching strategies and relative emphases upon program goals, the implications and needs for new teachers or teachers from another subject area, and general teacher preparation.
- Evaluation of the status of resource materials and facility needs.

Additional sources of information about program evaluation are:

Mechling, Kenneth R., "Taking Change: How Principals Can Improve School Science Programs," Principal January 1983, pp. 16-21; and,

Mechling, Kenneth R. and Oliver, Donna L., Promoting Science Among Principals: Handbook I-IV, National Science Teachers' Association, 1742 Connecticut Avenue, N.W., Washington, D.C., 1983.

STUDENT EVALUATION

The general purposes of student evaluation are to provide a) students with an understanding of their development and needs, b) teachers with a basis for planning necessary changes in teaching strategies and the curriculum, and c) information for parents and administrators. Evaluation should be related to program objectives and should consider a balance among science processes, manipulative and problem-solving skills, and content. Further, evaluation must be continuous and use a variety of approaches from informal observation of student activity to formal, such as achievement tests, performance (practical) items, checklists, and anecdotal records.

Some Evaluation Techniques

Informal observation techniques whereby teachers observe individual and group interactions in an activity can help to determine necessary skill development and the techniques required to improve these skills. Formal techniques include achievement (pencil and paper) tests and performance (laboratory) tests; checklists of processes, attitudes, and manipulative skills; and the examination of products such as oral presentations, reports and projects.

Partial Science Processes Checklist (5-9)

Monitoring student achievement in science processes may be helped by observing student behaviour in applying the processes. Samples of some behaviours are indicated in the following chart:

Process	Checklist of Behaviour
Measuring	Uses basic metric units as a standard; estimates, has basic concept of calibration (4-6). Uses simple measuring instruments with accuracy and precision; calibrates simple instruments; identifies appropriate standards for measuring lengths, area, volume and mass (7-9).
Classifying	Sorts objects into two sets on the basis of one property, two properties (4-6). Distinguishes between useful and relevant data, and irrelevant data; classifies a set of objects into two subsets; uses keys to identify objects and identify patterns (7-9).
Predicting	Predicts a change which is most likely to occur in a system after several observations; identifies a role for changes in a system; interpolates and extrapolates from simple graphs (4-6). Interpolates and extrapolates from more complex graphs; identifies or designs tests for predictions from data, begin to construct revisions of predictions based on additional information (7-9).

Manipulative Skills (Checklist)

Skill

- Sets up and stores apparatus safety
- Uses measuring instruments correctly
- Safe use of apparatus
  - heating
  - testing of compounds, e.g., no tasting)

Sample Performance Items

These items may be used individually or in a group (station) setting to test process and manipulative skills:

Bouncing Balls

Purpose: To test observing, measuring, interpreting and inferential skills.

Procedure: Provide students with three different balls labelled A, B and C, three different surfaces (board, rubber, carpet), metre stick and masking tape. Ask students to find out which ball will bounce best on all surface area. Ask them to record how they are going to solve the problem, record data, and justify their conclusions.

Microscope

Purpose: To test microscope skills, safety skills and observational skills.

Procedure: Ask students to identify labelled parts, to focus the microscope on coloured threads on a glass slide and identify the colour of the top thread; focus on and draw a letter "e" drawn on the slide; and focus on a cell (identify some parts).

References

Doran, R.L. Basic Measurement and Evaluation of Science Instruction. National Science Teachers' Association, 1980.

Hedges, W.D. Testing and Evaluation for the Sciences in the Secondary School. Wadsworth Publishing Company, 1966.

ADD OTHERS

CONCEPT MAPS

A concept map is a means by which the organization of subject matter is represented by a diagram. It is a two dimensional device which shows not only the concepts but the relationships among them. The relationships are represented by the words on connecting lines.

The concept map shown at the beginning of each unit will provide the teacher with a tool to plan, teach and evaluate. Each concept map serves as a model and teachers are encouraged to develop their own concept maps.

MISCONCEPTIONS IN SCIENCE

Misconceptions represent complete systems of explanations which are conceptually wrong. They are personal, in that students construct their own meanings from their own experiences. The misconceptions may seem incoherent to others, but the student doesn't see ideas as incoherent. The misconceptions are often stable; and even though new ideas are taught the old ones will remain. Some examples of misconceptions are:

1) that the mass of soil decreases as a plant is growing.

2) that molecules expand to make an object larger when it is being heated.

3) that the process of respiration is the breathing exchange of carbon dioxide and oxygen.

DISCREPANT EVENTS

A discrepant event involves a happening contrary to students' current beliefs.

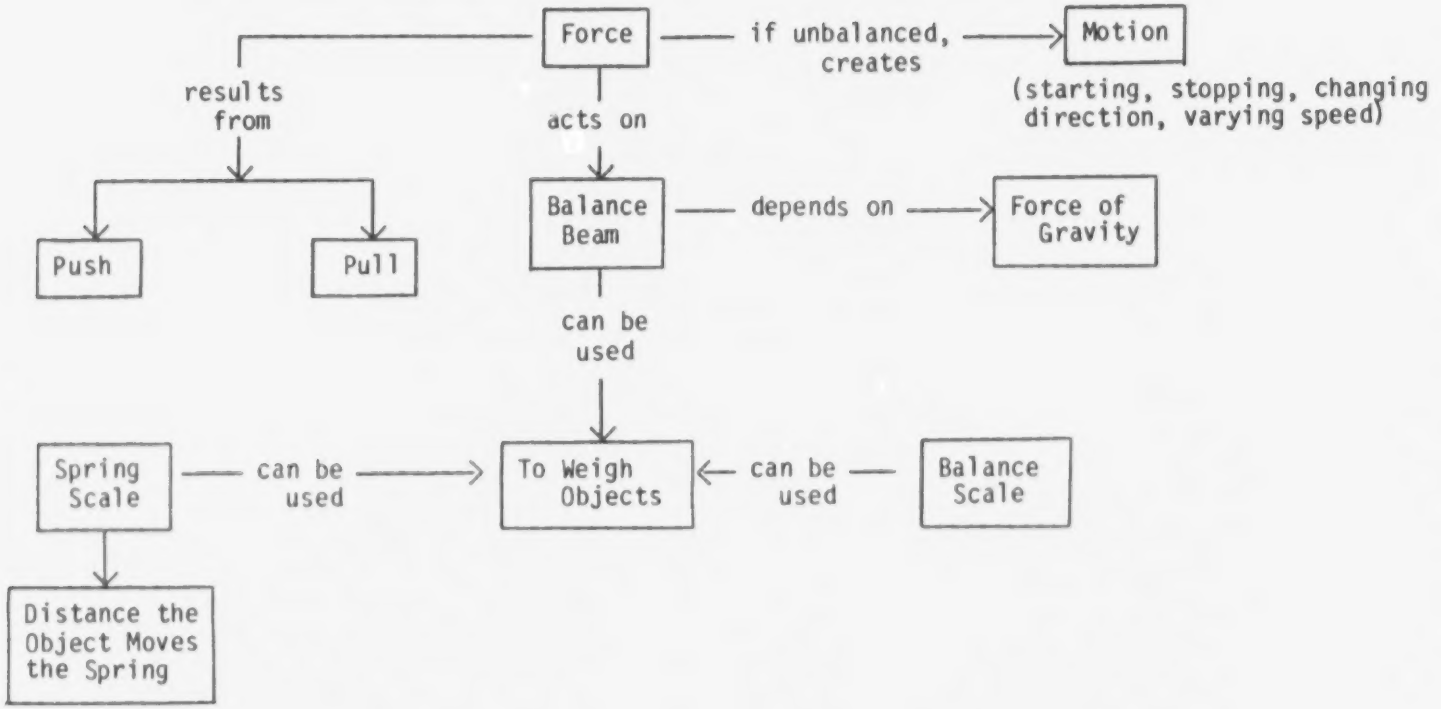
For example:

In this example, the students believe that the belt and the wooden stick cannot balance on the finger tip. This activity becomes motivational. It sparks their interest and gets students excited about science. When they see a discrepant event most students begin to wonder why and feel the need to have their questions answered.

Besides motivating students to learn scientific principles, discrepant events also provide a focus for fostering problem solving skills.

GRADE 5

CHANGES IN MATTER AND ENERGY: FORCE AND MOTION



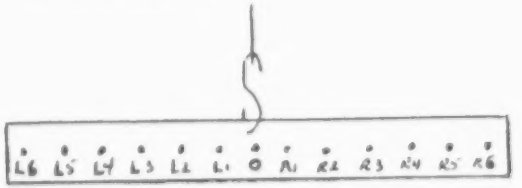
GRADE FIVE: CHANGES IN MATTER AND ENERGY: FORCE AND MOTION

RATIONALE: Forces are exerted on all objects. Motion will occur if the applied forces are unbalanced. The weight of an object may be determined by using balanced forces.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

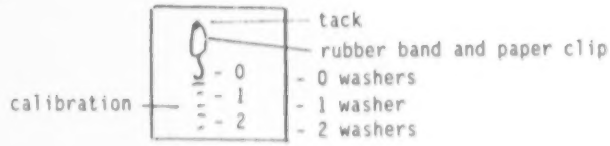
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Pushes and pulls, hereinafter called forces, are exerted on all objects around us.	a) Observe forces acting on objects and operationally define "force."	Look at pictures that indicate forces. Note what is causing the force and on what object the force is acting, e.g., vehicles, sports equipment. Operationally define a force as a push or a pull on an object. Let students make a game using two toy cars, a cardboard maze, and a magnet.
2. Forces can put an object in motion and change the motion of the object. Forces can speed up and slow down an object and can cause an object to turn.	a) Observe forces causing an object to be put in motion and to change its motion (direction or speed).	Students place a rubber ball or ping-pong ball on a table. Blow on it to start it moving. Blow on it to make it move the opposite way and in a circle. Alter the force of your breath to speed up and slow down the ball. Give the students a bar magnet and a steel ball or paper clip. Start the ball moving by using the bar magnet. Make it move in the opposite direction. Make it move in a crooked path and in a circle. Holding the magnet different distances from the ball, alter the speed with which the ball moves.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
3. The force that causes an object to speed up or slow down is called an "unbalanced force."	a) Predict the effects of forces upon objects and identify the variables (size, strength of student and position of student) that affect motion.	Have pairs of students engage in push of war contests. Students face each other and place their right feet side by side, touching. The right hand of each pushes on the palm of the right hand of the other. A third student says "go." When either of the pair moves his foot or lets his hand touch the floor, that person is the loser. Students should note that even though the loser was originally applying pressure in one direction, the winner made the loser change the direction of his original force.
	b) Infer that varying the height of the drop will vary the force exerted by an object.	Soft clay, sand, plasticine, jello, or play dough smoothed into a tray. Note: An object falling on it must make an indentation. Drop a marble from different heights and observe the force exerted (impact on the clay).
	c) Infer that different masses exert different forces when falling.	Two balls of same size but different masses are dropped from the same height. Observe the impact on the clay.
4. The balance point of a structure that must be supported will change as forces are applied to it.	a) Observe that the balance point of a metre stick will change as masses (forces) are added to it.	Find the balance point of a metre stick by sliding your finger under it. Make a balance beam. Art: Mobiles Place one, two, then three coins on one end of a metre stick and observe what happens to the balance point.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	b) Predict the corresponding forces required on either side of a balance beam in order to balance it.	Restore the original balance point without removing the coins by placing coins on the other end of the metre stick. Construct a balancing device as follows: On a piece of cardboard, make a pivot hole and 13 equally spaced holes. Suspend with a paper clip and string.  Place a paper clip at R4. Balance by placing a clip on the L side. Place a paper clip at R6. Balance the beam by placing another clip on the L side.
5. The mass of an object can be measured with a balance beam.	a) Measure the mass of objects using a balancing device.	The units of measure will be washers or paper clips. Attach the objects (pencils, pens) to position L6 with a clip. Determine the number of washers which must be added to R6 to balance the object.
6. A spring scale can be used to measure the weight of an object. The weight can be expressed as a function of the distance an object moves the spring.	a) Construct a device for measuring the mass of everyday objects.	Students should work in groups to make at least one of each of the following three spring scales. The scales should be calibrated according to a standard measure and the distance the standard measure moves the spring. (Use heavy washers).

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES

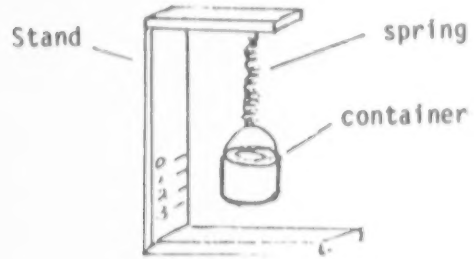
1.

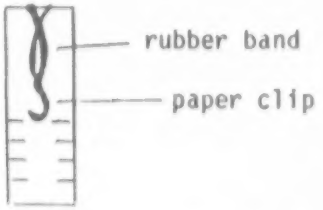


NOTE: The calibrations will not be equidistant.

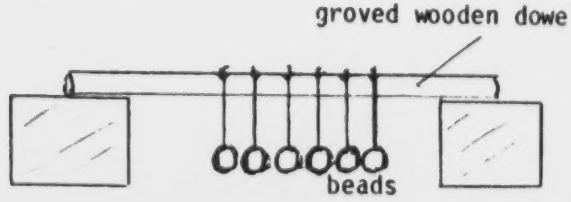
Social Studies: Research and write on first methods of weighing.

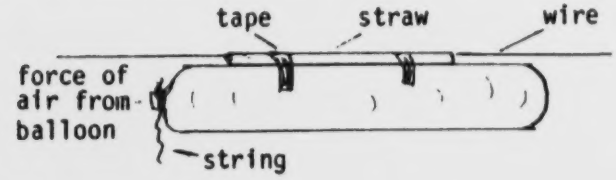
2. Nail a long piece of wood vertically to a wooden block base. Use a metal bracket or a small piece of wood from which to suspend a spring of medium strength. Attach a cup to the bottom of the spring. The top of the cup will coincide with the zero point which will be calibrated on the piece of wood. Use a washer or any other standard weight to calibrate the spring scale on the strip of wood. (Window shade rollers have springs of medium strength).



CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		3. Fold a file card in half and insert an equal sized piece of cardboard or other heavy material to reinforce it. Fasten the open edges with tape, glue, or staples. Punch a hole in the top of the card and insert a rubber bank through it. Attach a paper clip to the rubber band. Use a heavy washer or other standard weights to calibrate your spring scale. A modification of this spring scale can be made: If tne rubber band is cut so that it is only a single strand rather than the complete double strand, it can measure smaller weights. In both cases the spring scale can be calibrated by having zero correspond to the bottom of the rubber band.  NOTE: The calibration will not be equidistant.
	b) Measure weights with a spring scale constructed by the students.	Students now use the spring balances to measure the weight of everyday objects with reference to the calibration scale.
	c) Graph force and distance relationships.	Students now make graphs of force in washers vs. distance the spring stretched.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	d) Infer that the distance an object moves a spring in a scale is a method of measuring the weight of the object.	The home-made spring scales may be standardized by weighing the washers on a gram scale and transferring the weight in grams to the home-made spring scale. Note: Converting the number of washers moved or the distance moved in centimetres to the weight in grams could be a good exercise in the teaching of fractions.
7. Gravity causes objects to have weight.	a) Infer that weight is a force.	Attach a weight to a spring scale. Move the scale upwards quickly. Discuss the increased mass reading on the scale as related to gravitational force. Relate this to astronauts and exhibition rides, etc., i.e., mass of 100 grams will equal zero grams at the top of the ride.
8. All forces have direction. This can be represented by arrows.	a) Observe and record the direction of force applied upon an object.	Place a piece of cardboard under the wheel of a bicycle. Turn the pedal and note which way the cardboard moves. Stand on a piece of cardboard. Take a very big step. Note which way the cardboard moves.

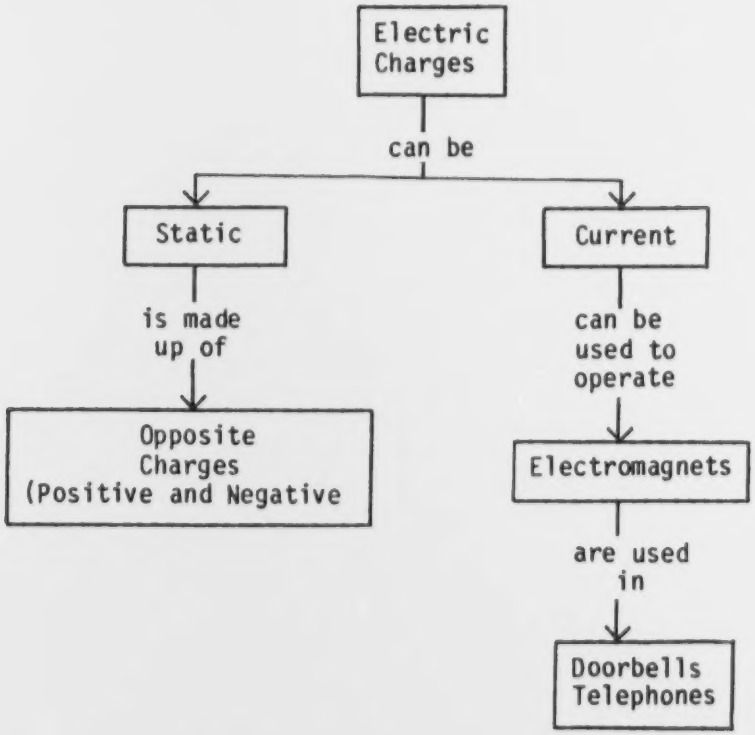
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		Show students pictures of forces acting on objects. Have the students draw arrows to show which way the forces are moving. Music: Make a musical instrument using rubber bands.
9. When a force acts through several objects (such as the links of a chain), it is transmitted through each with equal strength.	a) Observe the effect of a force on a series of several objects.	Attach a link of five identical elastic bands to a hook. Note that each stretches the same amount when a strong pulling force is applied. Use a marble rolled down a ruler to impact other marbles. (a curtain rod may be used instead of a ruler). A 2m. long section of 1/2 inch garden hose cut in half lenthwise and held in place between two chairs is another alternative. Use glass or wooden beads suspended from strings.  Discuss movement of force through objects such as train cars, curling rocks, croquet, snooker, crokinole.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
10. The force an object can exert or withstand depends upon the strength of the object.	a) Observe and record the strength of materials with reference to forces that they can withstand.	Suspend a string horizontally between two desks. Fasten a plastic pail to the string and fill the pail with calibrated weights until the string breaks. Record the maximum amount of force it can exert or withstand before it breaks. Repeat, using different types of string (or threads). Make a chart of the results and then graph them using a bar graph.
11. When an object exerts a force on another object, the latter object exerts an equal and opposite force if the system is at rest.	a) Infer that balanced forces act equally in opposite directions.	Have pairs of students of approximately the same weight hook up a pair of heavy duty spring scales. Have the students pull in opposite directions. Have two other students take the reading of each scale. Note that each scale reads the same if the students are not moving. Do the balloon on wire experiment. 

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		For an alternative activity, tape a brown paper bag to the straw in place of the balloon. Then put the inflated balloon in the bag and release the air rapidly from the balloon. This will lead to further discussion on why less distance is covered and why the speed was not as great.

GRADE 5

Changes In Matter and Energy: Electric Charges



GRADE FIVE: CHANGES IN MATTER AND ENERGY: ELECTRIC CHARGES

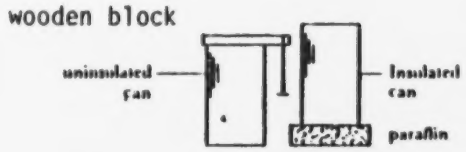
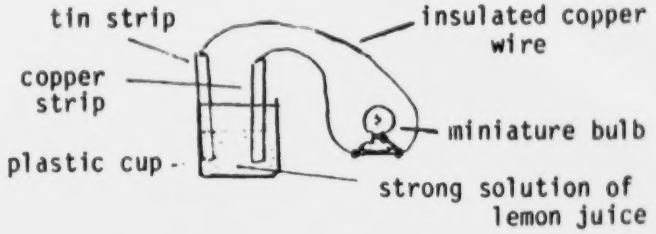
RATIONALE: Electric charges can be produced in many ways and can be converted from other forms of energy. Electric charges may be used to make electromagnets which have many uses in our homes.

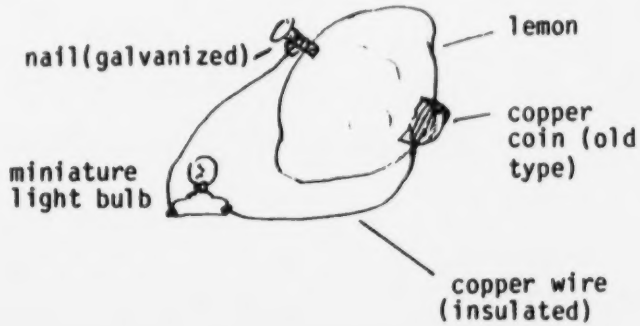
* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

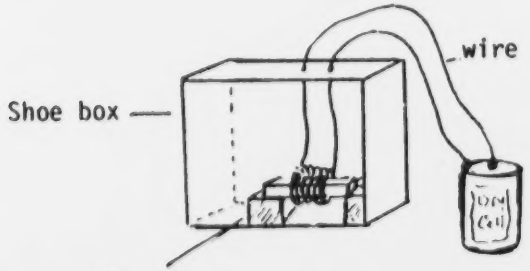
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. When some materials are rubbed together, they acquire an electrical charge.	a) Observe that a material may become electrically charged if it is rubbed against a material.	Start off with a simple activity using static electricity to do work. For example, tape the end of a piece of light thread (30 cm. long) to a desk and try to lift it using equipment given by the teacher. e.g.: comb, plastic, wool. See if students can arrive at a method of raising the thread. Hold a neon glow light and shuffle across the room on nylon or wool carpet. Notice that the glow light lights up. This can also be done with a small fluorescent light. It is very effective in a darkened classroom.
	b) Hypothesize that the amount of electrical charge can be increased by rubbing two materials against each other an increased number of times.	Rub a comb or plastic brush through your hair. See how many pieces of paper you can pick up with it. Try twice as many strokes to see if you can pick up twice as many pieces of paper. Note that freshly washed or clean hair will give the comb a greater charge.
	c) Design an experiment that tests the ability of a balloon to stick to different surfaces.	Take a number of balloons and rub each the same number of times with the same material and apply each to a different surface.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	d) Design an experiment to test if one can obtain a shock from other surfaces (wood, linoleum).	Shuffle your feet across a rug of nylon or wool. Then touch a metal object. Note the shock. Touch the tip of a partner's finger. Touch objects such as wood and plastic. Discuss ways that one can prevent getting shocks (particularly in winter).
2. An object that has an electrical charge may attract an uncharged object. An object that has an electrical charge can attract or repel another charged object.	a) Observe the attraction of an uncharged object by a charged object.	Rub two items such as a sweater and a balloon or a ping pong ball and a plastic bag together. Note that these objects which now have an electrical charge will attract small objects which are suspended on pieces of thread, e.g., puffed wheat, small ball of foil, toothpick, broomstraw.
	b) Observe the repulsion and the attraction of two electrically charged objects.	Charge an object such as a comb or a plastic spoon. Hold it near a slow-running water tap. Note that the charged object will deflect the flowing water. Have the students vigorously rub a strand of wool with a plastic bag. Suspend the wool over the desk. Hold it in place with a wooden block. Place uncharged objects such as wood, a rubber band, and a feather near the wool. Note that the strand of wool is attracted. Rub the uncharged objects with the same plastic bag. Note that the wool is repelled. Hold five pieces of wool together at one end and let them hang. Then, rub the five pieces and let them hang again. Note that the ends of the wool now repel each other.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
3. There are two different kinds of electrical charges: like charges will repel and unlike charges attract.	a) Infer that there are two different kinds of electrical charges.	Hold two charged strands of wool close to each other. Note that they repel. Hold two charged strands of plastic bag together. Note that they also repel each other. Hold a stand of wool and a charged strand of plastic bag near each other. Note that they attract each other.
4. An electrical charge can move from one object to another. This produces an electrical current.	a) Infer that an electrical charge can be carried from one object to another.	Suspend two balloons from threads about ten centimetres apart. Comb hair with a plastic comb and touch one balloon. Touch the other balloon at the same time with a glass test tube which has been rubbed with plastic wrap. Observe. Remove the labels from two large juice cans. Place one one a block of paraffin. Place a block of wood on the other. The can on the paraffin is the insulated can. It should not be touched nor should anyone stand too close to it. The can with the block on it is the uninsulated can. Hang a tack on a string from the top of the uninsulated can. Rub a plastic bag with wool and touch the insulated can with the plastic bag. Repeat five or six times. The tack will be attracted to the insulated can. When it touches it, it will gain an electrical charge and move back to the uninsulated can. The charge will be drained off and the tack will again be

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		attracted to the insulated can. As long as the insulated can is charged with electricity the tack will move back and forth. 
5. An electric charge can move through a conductor to produce an electrical current.	a) Observe the effects on an electrical charge of joining two insulated objects of different charges. b) Predict and verify the kinds of material which can carry an electrical charge.	Place another insulated can a metre away from the original insulated can. Join them with a thin wire. Touch the third can with a plastic bag as above. Observe that the tack will move back and forth. Test this system with aluminum foil, wet string, and string that has been soaked in a salt solution.
6. An electrical current can be produced by chemical means.	a) Observe that two different** metals can produce an electrical current when they are placed into an acid or a salt solution.	Construct a chemical cell as shown. Substitute lemon juice with orange juice, salt water or vinegar, use other metals such as aluminum or iron (several galvanized nails). 

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		An alternative activity could be:  NOTE: The lemon must be softened, but the skin cannot be split.
	b) Observe the inside of a dry cell or small battery.	(Teacher demonstration). Cut open a dead cell or battery and observe the parts. Note the similarity between the cell and the simple electric current producing device.
	c) List the uses of dry cells ** and batteries.	Use pictures to show batteries in cars. Teacher can demonstrate a walkman which uses conventional batteries.

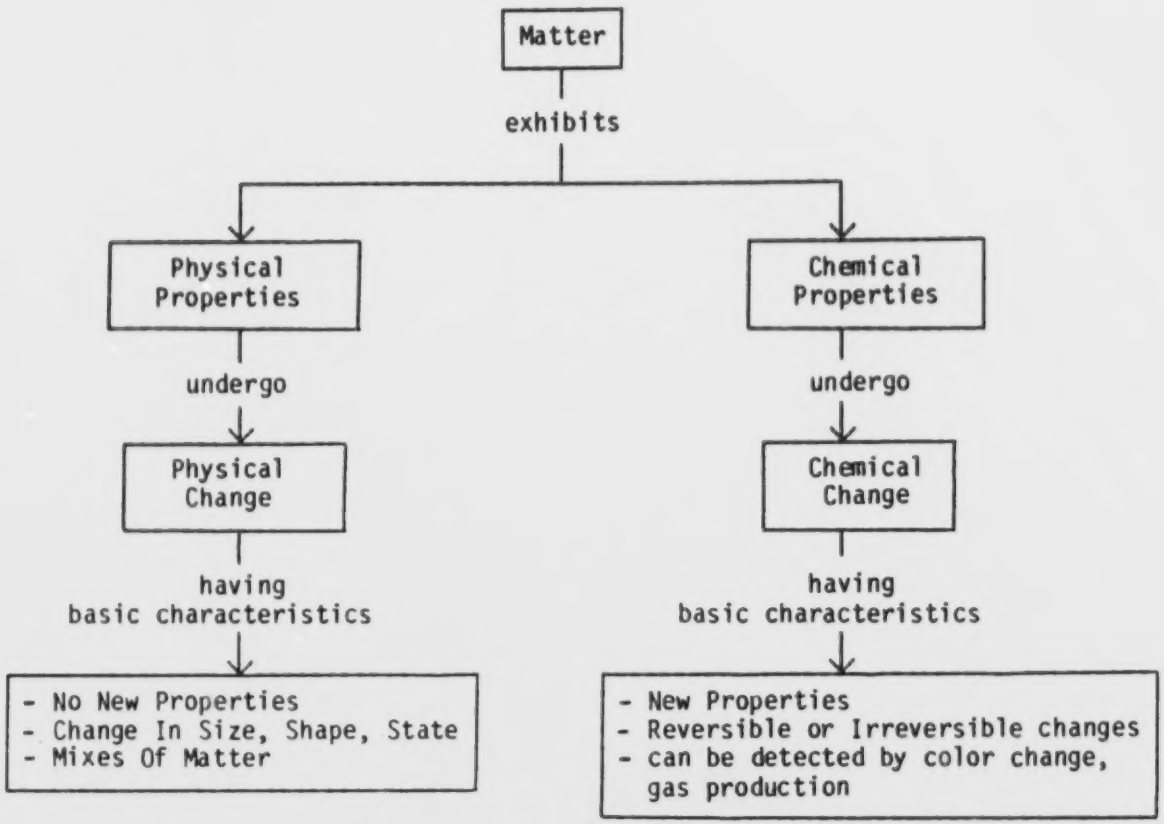
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
7. An electrical current can be detected with a magnet because an electrical current exhibits magnetic properties.	a) Infer the presence of elec-** trical currents by testing with a magnet.	Make a current detector by wrapping a magnetic compass with about twenty turns of insulated wire and connecting it to a cell as in the diagram. Note: Maximum deflection occurs when the compass is wrapped with coils parallel to needle. When an electrical current flows through the wire the needle of the compass will move. An alternative activity would be produce a coil of many turns using very tin lightly insulated copper wire and leave the two ends bare so that they can be attached to the battery. An alternative activity would be to produce a coil of many turns using very thin lightly insulated copper wire and leave the two ends bare so that they can be attached to the battery.  · magnet resting on a support (a U-shaped magnet can be used)

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		When an electrical current flows through the wire the coil will move (practice reversing the wires at the battery). Test for the presence of an electrical current in the following cells: . a vinegar soaked blotter placed between a penny and a paper clip; . a wet cloth sprinkled with baking soda placed between an aluminum pan and bunched up copper wire; . a piece of paper towel soaked with lemon juice and placed between a strip of zinc and a strip of copper; . a galvanized pail lined with cloth, and copper screening placed against the cloth. Fill the pail with a salt solution.
8. When an electrical current is passed through wire that is coiled around certain metals, the system will become an electro-magnet.	a) Construct a simple electro-** magnet and hypothesize that an increase in the number of coils increases the strength of the electro-magnet.	Wrap five coils of insulated wire round a large iron nail. Connect the wire to both terminals of a dry cell. See how many tacks or paper clips it can pick up. <u>Caution</u>: Disconnect immediately after use. Repeat using 10, 15, 20, 25, 30, and 35 coils. Each time record the number of tacks or paper clips picked up. Make a graph to show your results.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	b) Design an experiment to test the effect of different variables upon the strength of the electro-magnet.	Control all variables except the number of coils of an electro-magnet. Note: This activity can be extended by controlling other variables such as thickness of wire, strength of cell, size of nail, composition of nail.
9. Devices such as doorbells, telephones, burglar alarms work on electro-magnets.	a) Observe the working of a doorbell (telephone or burglar alarm).**	Connect a doorbell in a circuit with a switch or push button. Test the doorbell to make sure it rings. Take the cover off and observe the electro-magnets, hammer, spring and con- tact points.
ENRICHMENT:		
An electric motor depends upon an electro-magnet.	a) Construct an electric motor** or a simple electric buzzer.	Use resource books and have a group of students construct either the electric motor or the electric buzzer. * Such as Addison-Wesley: Science Electric Charges and Currents, page 158.

GRADE 5

CHANGES IN MATTER AND ENERGY: PHYSICAL AND CHEMICAL CHANGES



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GRADE FIVE: CHANGES IN MATTER AND ENERGY: PHYSICAL AND CHEMICAL CHANGES

RATIONALE: Changes in matter can be classified as physical or chemical. A physical change occurs when an object changes shape. Some physical changes are reversible. A chemical change is when a new material with new properties has been formed. Some chemical changes are easy to reverse while others are irreversible.

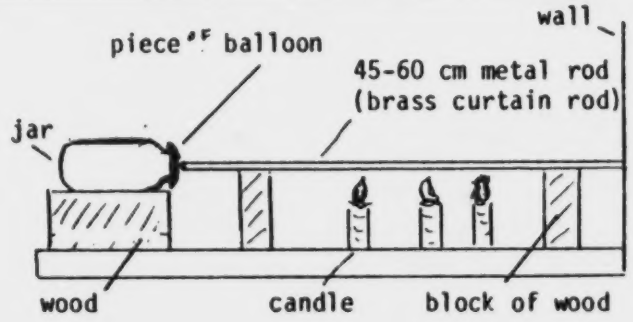
* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Some physical properties of objects can be observed using the senses.	a) Observe the physical properties of some everyday objects by the use of the senses.	Seeing: Observe the characteristics of colour, shape, size, rough/smooth, dull/shiny, transparent/opaque, bouncy, liquid/solid/gas. Art: Make a collage of the dominant area of one of the senses, e.g., sight--flowers, birds, etc.; sound--records, radio. Feeling, touching or lifting: Observe an object as to hard/soft, smooth/rough, cold/warm, stretchy, heavy for its size/light for its size. Hearing: Observe whether the object ticks, rings, rattles, hisses or makes no sound. Smelling: Smells/does not smell, sweet/sour, clean/dusty, pleasant/pungent. Caution: Instruct children when observing through the sense of smell, never to put the nose directly near the source, but to waft the odour toward the nose with the hand.

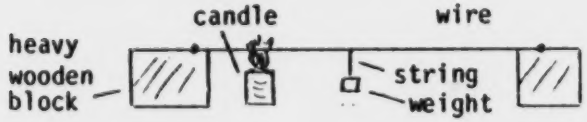
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		Integration: Since the basis for observing physical properties is largely based upon opposites, this may be a good lead in to the study of antonyms in language arts. Tasting: Observe tastes. Sweet/sour, smooth/bitter, cold/hot. Caution: One should never taste an unknown substance. Beware of allergies to certain foods and diabetes.
2. No two kinds of matter are alike in all their properties.	a) Observe and compare the properties of different kinds of matter.	Observe equal amounts of white sand, sugar, and salt to see if you can identify them. Use your senses of sight, touch and smell. Look at the materials listed above under a microscope or magnifying lens and rub samples of each between your thumb and forefinger.
	b) Infer that each object has one or more properties which identify it.	See how much of each will dissolve in a glass of warm water. Weigh equal samples of each. Observe the odours of the samples. Look for differences in whiteness. Note whether they are shiny or dull. Students should note that even though all three objects have similar properties, each has unique properties.
3. Objects can be classified according to their properties.	a) Observe, measure, and classify objects according to common properties.	Use the following criteria to compare and classify the metal part of a screwdriver, aluminum strip, a glass tumbler, bricks and cotton.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		. strength: the resistance of the object to breakage; . stiffness: the resistance to bending; . brittleness: the liability to crack when bent.
	b) Observe, measure and classify metals according to their hardness.	Try to scratch different metals using a fingernail, a brass or copper pin, a file and an iron nail. Make a scale of hardness according to the ease with which the objects can be scratched.
4. A physical change occurs when an object changes shape.	a) Infer on the basis of evidence, that the changes are physical when an object changes its shape.	Stretch a rubber band, or hammer a coil of copper wire. Work with modelling clay or plasticine. If dried, modelling clay does not easily return to its original shape.
5. A change in the state of matter may be a physical change.	a) Infer that a change in state may be a physical change.	Examine an ice cube in terms of the properties of ice. Allow the ice cube to melt and examine the properties of the resulting water and make inferences.
6. The expansion and contraction of matter is a physical change.	a) Observe the expansion and contraction of a metal rod.	Observe the effects of heating a metal rod and make inferences. (Rod should be lightly touching the balloon).

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES



An alternative activity could be to use a wire with a weight attached.



b) Infer that expansion and contraction are physical changes.

7. Liquids can be mixed with liquids to produce a physical change.

a) Observe the mixing of liquids.

b) Infer that the rate of mixing of liquids can be affected by variables such as heat and force.

Place a drop of food colouring into a clear container of water.

Repeat the procedure but drop the food colouring from just above the water, 100 cm above the water.

Drop heated food colouring into cold water. Repeat by dropping cold food colouring into hot water.

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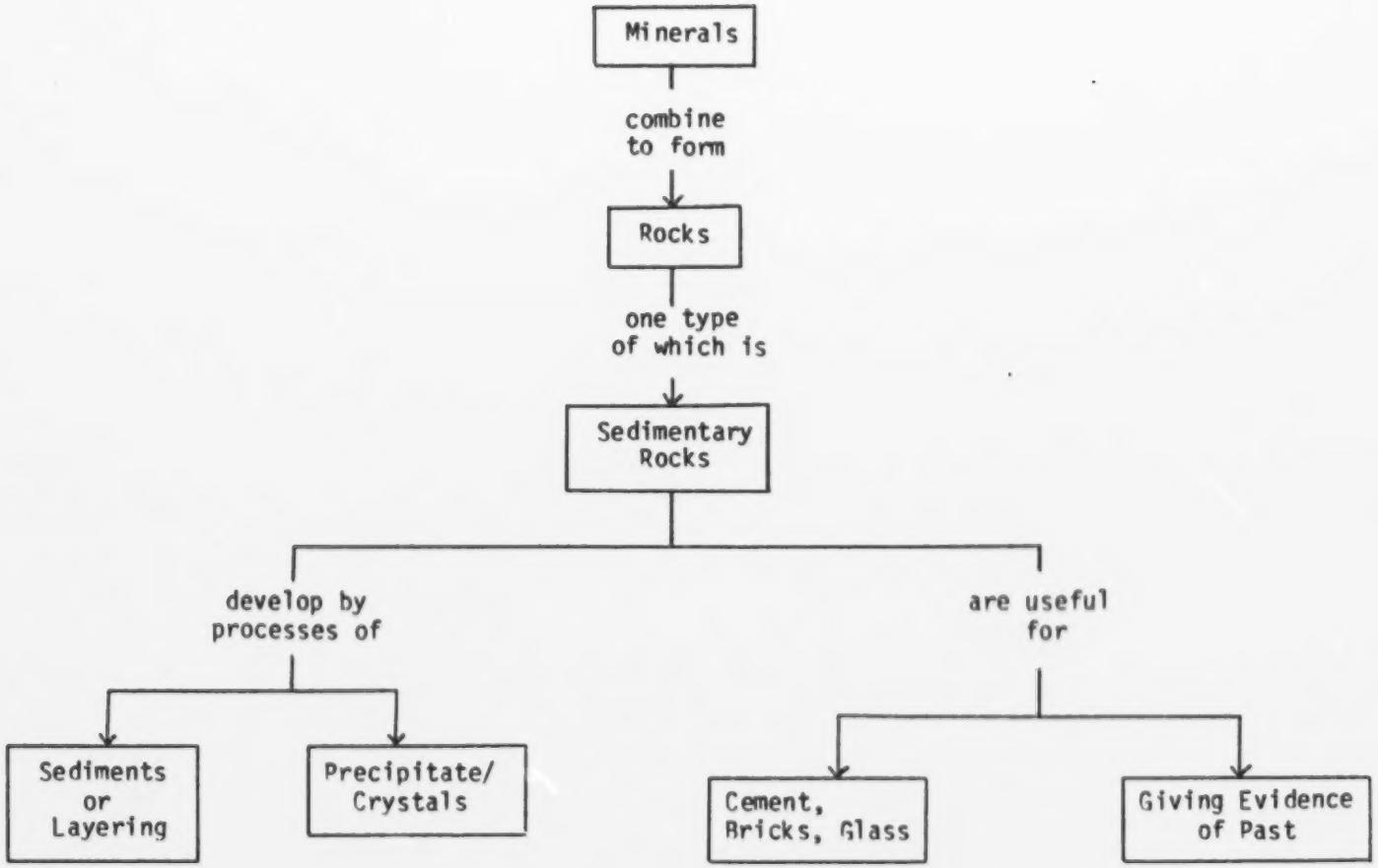
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Solids can be mixed with hot water to produce a physical change.	a) Observe that a solid will mix with (dissolve in) water.	Place a large piece of candy or sugar cube in a container.
	b) Observe that the rate of mixing is increased when the solid is granulated or powdered.	Crush the same amount of candy and place into a second container. Observe that it takes less time to mix.
	c) Infer that the size of the particle (surface area) affects the rate of dissolving.	
	d) Infer that temperature affects the rate of dissolving.	
9. Chemical changes produce new materials with different properties.	a) Observe materials undergoing chemical change.** Note: Stress that the changes may be irreversible or difficult to reverse.	Make a balance scale or use a gram scale. Weigh a sheet of paper. Place the paper in a pie plate. Burn the paper. Weigh what remains. Note the colour, odour, texture, thickness and weight. Place an ordinary iron nail and a painted nail in a clear container of water. The paint must be waterproof, e.g., acrylic spray paint or artist's oil paint. This experiment will take several days so allow for other activities during this time. The activity could also be done with steel wool.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
10. Chemical changes may be detected by using colour tests.	a) Observe a colour change when two or more substances are mixed together. b) Infer that the colour change signifies a chemical change and that some changes are reversible.	Pour water into two small containers. Put enough bromothymol blue into each container to get a strong blue colour. Blow through a straw into one of the containers. Note that the colour changes to yellow or green. This is due to the fact that carbon dioxide has been introduced into one of the containers. Leave containers overnight and compare the colours. (This is a reversible chemical change because the carbon dioxide gas leaves the solution.) Pour clear soda water into a container. Pour an equal amount of water into another container. Put several drops of bromothymol blue into each container. Note that the soda water turns yellow or green while the plain water turns blue.
11. Some chemical changes can be detected by the release of gases.	a) Observe the evidence of chemical change (gas bubbles). b) Infer how the use of technological products such as alka-seltzer are used by humans (indigestion).**	Place an alka-seltzer tablet into a container of water. Shake about one-half a container of powdered yeast into a clear container. Add 15 ml of warm water. Set the mixture in a warm place and record any evidence of change.

GRADE 5

EARTH SPACE AND TIME: THE CHANGING EARTH



GRADE FIVE: EARTH SPACE AND TIME: THE CHANGING EARTH

RATIONALE: Sedimentary rocks are important in our daily lives. Cement, glass, fossil fuels are but a few materials that we obtain from sedimentary rocks. The structure of sedimentary rocks provides clues as to how the earth has changed.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Moving water wears away the land and makes rocks smaller.	a) Infer that moving water is capable of making rocks smaller.	Review grade 4 (Water and Land).
2. Those rocks which consist of minerals exhibit many structures and properties.	a) Classify rocks according to structure and the properties of colour, hardness, layering and grain size.	Divide the class into groups and obtain enough rock samples of many different kinds so that there are at least 12 specimens for each group of students. Ask students to sort rocks according to the properties they see. Give them hand magnifiers to use. List on a chart the groups and the common properties. Have them give the reasons for their classifications. Encourage them to order within the properties, e.g., hardness, colour, grain, size. Mines, Resources and Environmental Management (Rock Sets) For information on up to date publications, including maps contact: Information Centre, Manitoba Energy and Mines, 555-330 Graham Avenue, Winnipeg, Manitoba, R3C 4E3.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
3. Process of crystallization relates to mineral growth in nature.	a) Observe the process of crystallization and discuss how this relates to mineral growth in nature.	Have students grow their own crystals: Fill jar with hot water, add Borax a little at a time and stir until no more will dissolve; let settle and pour clear liquid into new jars; tie a weighted thread (use thumb tack or washer) to a pencil and suspend in liquid; place jar where it will not be disturbed and observe every day; measure daily. Discuss the formation of stalactites and stalagmites.
4. Some rocks are formed in layers. Those that are laid down in water or on the land are called sedimentary rocks.	a) Infer order of deposition from layered structures.	Collect layers of lint from the clothes dryer and have students infer the origin and order of the layers.
	b) Measure the speed of settling particles. Communicate, using graphs, the speed at which particles settle.	Conduct a sinking sand race: Get a tall empty bottle and fill it to the top with clean water; tape a strip of black paper along one side of bottle from top to bottom to help see the particles, and use a strong light and a magnifying glass; drop a pinch of clean sand in the water and watch grains as they sink. Do they all fall at the same speed? Then use different kinds of particles. Time the speed of each size. Graph results. Discuss the variables which may affect the results (size to mass ratio, height of drop).
	c) Hypothesize on the basis of the previous activity, the order in which rock particles will settle.	Mix sand, pebble, water, and garden soil in a large jar. Seal and then shake it. Predict settling of particles and subsequent layers. Observe. Note relative sizes of particles in layers. Discuss.

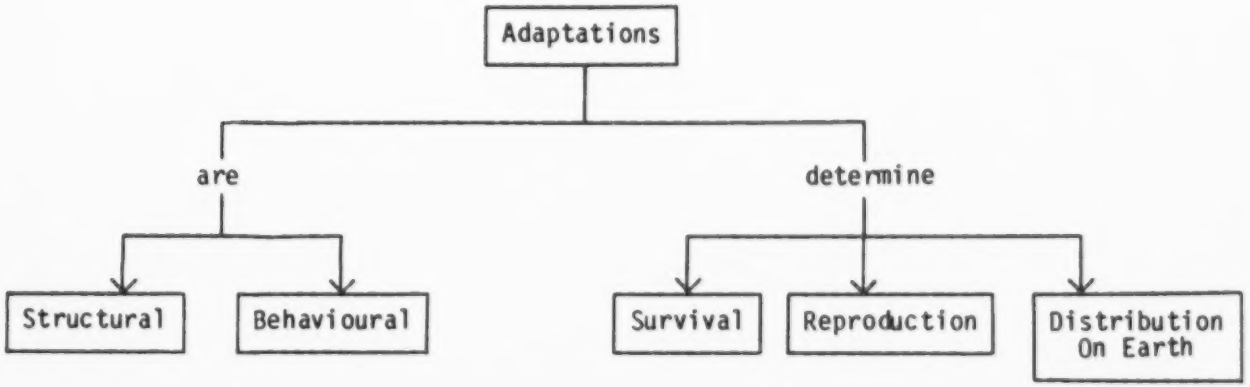
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	d) Infer the process of sedimentation for some layered rocks.	Obtain samples of coarse and fine grained bedded sandstone or use pictures of layered rocks and have students infer their origin. Add layers of different kinds of mud to a jar of water daily to form a model of how layering takes place in sedimentary rock.
5. Sedimentary rocks consist of two main types: those from sediments and those precipated from a solution.	a) Observe the role of cements in forming some sedimentary rocks.**	Make conglomerate with pebbles and glue. (Conglomerate is a naturally formed cement.) Have students examine some samples of conglomerates both natural and man-made. Social studies: Obtain samples of limestone and examine for fossils. This is an opportunity to study glacial deposits in Manitoba. Field Trip: Look for fossils and tracks.
	b) Predict the formation of crystals by evaporation.	Let saturated salt solution evaporate to form rock salt. Examine with magnifiers. Observe rock samples, sand grains in shale, and fossil fragments in limestone using a microscope. Collect samples of man-made bricks and stone for housing facades. Examine and compare. Discuss how they may have been made. The main fragmental kinds of shale, sandstone, and conglomerate. The main precipitate kinds are limestone, salt, and gypsum.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		Have students make impressions of leaves, shells, water prints in mud, or modelling clay. Take a walk to look for rain prints, foot prints, bird tracks, etc. Examine samples of actual rocks with structures such as layers, rain prints, mud cracks, ripple marks or fossils. Have students suggest how they were formed. Examine pictures if rocks are not available.
6. Many useful materials come from sedimentary rocks.	a) List some common materials which come from sedimentary rocks.**	Look at pictures of materials such as cement, building bricks, baking soda, fossil fuels, materials made of iron, glass, medicines. These are all associated with sedimentary rock.
	b) Discuss the importance of cement, glass and bricks.**	Examine cement, bricks, glass. List and discuss various ways that these materials are used.
7. The structures in some sedimentary rocks help give us clues about their past history.	a) Infer some of the conditions under which rocks might have been formed.	Mix plaster of paris and water and have the students simulate "fossil" impressions of objects they wish to preserve for the future, e.g., pennies, toys, leaves, bones, nuts, etc. Coat the outside of an object with vaseline and then press into the plaster. Let it stand and then remove the original article to leave the imprint.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Fossils are the remains or traces of plants or animals in sedimentary rocks.	a) Simulate fossil formation and infer change on the basis of fossil evidence, how plants and animals have changed over the years, and what ancient climates were like and how they have changed.	Make a prehistoric diorama with dinosaurs and vegetation. Go on a fossil collecting trip or visit a museum. Compare fossils with modern specimens. Compare past climates (from diorama) with present-day climates.

Grade 5

INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: ADAPTATIONS TO THE ENVIRONMENT



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GRADE FIVE: INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: ADAPTATIONS TO THE ENVIRONMENT

RATIONALE: Adaptations help organisms survive in their environment.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. An adaptation is a structural or behavioural change in an organism which improves its ability to survive in its environment.	a) Identify differences in adaptations among animal groups.	Review basic differences among mammals, reptiles, amphibians, birds, fish and insects; and note that the survival of the group is dependent on its adaptation to its environment.
	b) Infer that adaptations may be structural.	Introduce the definition of structural adaptations and have students examine the specific structural adaptations of the organism such as a bird's hollow bones, gills of a fish rather than lungs. Discuss how these particular physical characteristics are advantageous to the organism. Provide a list of structural adaptations in plants such as flower petals and root systems; and discuss how thee adaptations are necessary for survival in the environment. (Specifics of the two types of plant roots - tap and filament could be looked at).
	c) Infer that adaptations may be behavioral.	Introduce the definition of behavioral adaptations and have students examine the specific behavioral adaptations such as a cat's stealth, bird's song, a killdeer's habit of pretending to be injured, animals such as musk-ox herding for protection and starlings taking over bluebird homes.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		Discuss how these particular behavioral characteristics are advantages to the organism. Provide a list of animals for the class and brainstorm for examples of structure and behavioral adaptations.
	d) Operationally define an adaptation as any characteristic of an organism which provides it with an advantage for survival in a specific environment.	Have students observe a specific organism and list as many adaptations as possible. Each adap- tation should then be defined in terms of its function. Through discussion of the function of each adaptation, students should infer how adaptations to an environment give the organism an advantage for survival in the environment. Provide examples with pictures of how animals have adapted to their environ- ment over the centuries and have made an important impact in science studies. i.e., gypsy moth in England during the Industrial Revolution and the Galapapos Islands studies of its inhabitants.
	e) Predict the most useful structural and behavioural adaptations an animal should exhibit in any given environment.	Students are assigned a specific environment, e.g., pond, desert, tundra, and are asked to design and draw a picture of an imaginary animals that could survive in that particular environment. (The opposite can also be done). Students should be prepared to discuss the features of their animal and explain reasons for their choice of features. This activity may also be done with plants.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
2. Animals may adapt by changing a specific structure over a number of years.	a) Observe animals in the action of grasping, silent movement, movement in water, tearing flesh, digging and balancing.	Have students observe pictures or slides of animals and discuss how each has adapted to eventually be able to perform the action.
	b) Observe different types of body coverings, compare their functions and infer the advantages and disadvantages of each.	Brainstorm the various types of body coverings that exist and compile a list ofadvantages and disadvantages for each. Students should discuss questions such as "why don't frogs have scales?"
3. Plants are distributed throughout the earth based on the ability to adapt.	a) Observe coniferous and deciduous trees and compare the benefits of each type of adaptation.	Have students observe coniferous and deciduous trees and their distribution in terms of both latitude and altitude. Benefits of each of these adaptations should be listed with particular emphasis on moisture availability and climate. Use World and North American maps showing deciduous and coniferous distribution. Have students examine a broadleaf and a pine needle under a magnifier and with a microscope. Similar structures should be identified and compared.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		Students examine a broadleaf and a pine needle under a magnifier and with a microscope. Similar structures should be identified and compared.
4. Adaptations help in the reproduction of plants and animals.	a) Observe and classify adaptations that help in seed dispersal for plants.	Individually or in groups, students make a seed collection and classify each type of seed in terms of the way it is dispersed in nature. Students should record where the seeds were found and if possible identify the plant from which each seed came. Students should observe each seed carefully to identify those structures which help in its dispersal. Students should try to find relationships between where the plant grows and how it disperses its seed. This activity should be done in the autumn. Seeds are dispersed by being carried by wind, water or animals.
	b) Observe adaptations that help in the survival of a chicken egg.	Have students examine a chicken egg and then crack it into a bowl. Students examine the shell and the membrane under the shell with a microscope. Then examine the yolk and discuss where the chick embryo obtains its food for growth and development. Discuss coloring of females, coloring of eggs, and location of eggs.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
5. Animals show adaptations to environmental change.	a) Observe patterns of behaviour in animals and relate them to survival in a changing environment.***	Have students observe live or on film migration of birds, salmon, monarch butterflies or caribou. Discuss environmental changes which cause migration to occur. Construct a map showing the major migration routes of a particular animal. Have students observe animals which hibernate in the winter months, e.g., insects, bears, squirrels. Discuss environmental changes which cause hibernation to occur. Integrate with social studies.
	b) Infer which adaptations allow animals to hibernate, migrate or remain active during the winter months.	Have students construct a chart listing character- istics of animals which hibernate, migrate, remain active. Present students with information about a little known animal and ask them to predict its seasonal behaviour based on its adaptations. Note: Research projects, plant studies in vacant lots, and activities such as the owl pellet activity should be encouraged in this unit.

APPENDIX "A"

GENERAL PROGRAM OVERVIEW K-4

THEMES	K	1	2	3	4
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS	LIVING AND NON-LIVING	ANIMALS AS LIVING ORGANISMS PEOPLE ARE LIVING ORGANISMS	LIVING ORGANISMS IN THE ENVIRONMENT	LIFE CYCLES	POPULATION INTERACTIONS
CHANGES IN MATTER AND ENERGY	PROPERTIES OF OBJECTS	PROPERTIES OF MATTER	FLOTATION: A PROPERTY: OR MATTER	CHANGES IN MATTER ENERGY, HEAT AND TEMPERATURES AIR AND AIR PRESSURE	ELECTRICITY SOUND STRUCTURES
EARTH, SPACE AND TIME	SIZE, POSITION AND TIME	COMPARING AND MEASURING EVENTS	MEASURING TIME, OBJECTS AND POSITION LIGHT AND SHADOWS	THE EARTH, SUN AND MOON	WATER AND LAND

5	6	7	8	9
ADAPTATIONS TO ENVIRONMENT	INTERACTIONS OF POPULATIONS WITH ENVIRONMENT	MICROBES AND ECOSYTEMS	CELLS AND ORGAN SYSTEMS PLANTS AND THE ENVIRONMENT	REPRODUCTION AND HEREDITY PLANT AND ANIMAL INTERACTIONS
ELECTRIC CHARGES FORCE AND MOTION PHYSICAL AND CHEMICAL CHANGE	FORCE AND MOTION SIMPLE MACHINES	LIGHT PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER	HEAT ALTERNATIVE FORMS OF ENERGY FLIGHT	FORCE, WORK AND MOTION CHEMICAL INTERACTIONS
THE CHANGING EARTH	WEATHER THE EARTH IN SPACE	ROCKS, MINERALS AND SOILS THE OBSERVABLE UNIVERSE		CHANGING EARTH'S CRUST

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APPENDIX "B"

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
1.0 Observing			
1.1 Identity and state properties and changes in an object using senses	ID	D	E
and events	ID	E	E
1.3 Identify and describe elements of a system, motion of an object relative to a reference point	I	D	E
1.4 Distinguish between qualitative and quantitative observations		ID	E
1.5 Distinguish between observation and inference		I	DE
2.0 Measuring			
2.1 Select and use appropriate instruments with precision. Use SI	I	ID	ID
2.2 Design and construct simple measuring devices (measuring time, scales, hygrometers)		I	I
2.3 Calculate the efficiency of simple machines			ID
3.0 Classifying			
3.1 Distinguish between objective and subjective information, fact and inference			ID
3.2 Sort objects into groups according to similarities and differences and/or quantitative measurements	I	ID	DE
3.3 Develop classification systems	I	I	ID
3.4 Use a dichotomous key			I

CODE: I - Introduced to a limited degree.
D - Developed into new areas or in more complex forms.
E - Extend process (student controlled and directed).

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
4.0 Inferring			
4.1 Identify observations which support an inference	I	ID	DE
4.2 Describe additional observations needed to test alternative inferences	I	ID	DE
4.3 Identify inferences that should be accepted, rejected or modified on the basis of additional observations		ID	DE
5.0 Communicating			
5.1 Describe and sequence a series of events orally or in writing	ID	DE	E
5.2 Construct a simple data table or graph	I	DE	E
5.3 Construct a line graph and represent principles using a mathematical format		ID	D
5.4 Write an accurate report describing events		I	D
6.0 Predicting			
6.1 Make and confirm simple predictions using an activity	ID	E	E
6.2 Predict the consequences of removing or altering one or more system-components		ID	DE
6.3 Interpolate and extrapolate from patterns or graphs; predict from formulae		I	D
6.4 Design tests for predictions; maintain, remove, or modify predictions		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
7.0 Interpreting Data			
7.1 Distinguish between relevant and irrelevant data using observation, reading, or listening	I	ID	DE
7.2 Recognize limits of data, biases and their distortions		I	D
7.3 Interpret cause and effect relationship within a problem solving situation, construct inferences from data		I	D
8.0 Recognizing and Identify a Problem			
8.1 Recognize patterns and events	I	D	D
8.2 Delimiting and phrasing a problem		ID	DE
9.0 Controlling Variables			
9.1 Identify relevant variables manipulated and responding to test a given hypothesis		ID	DE
9.2 Examine collected data and select relevant data		I	D
9.3 Identify variables (manipulated and responding from observations)			ID
10.0 Hypothesizing			
10.1 Distinguish between a) opinion and hypotheses		I	D
b) hypotheses, theory and Taw			ID
c) inferences and hypotheses			D
10.2 Identify a testable hypothesis and revise when indicated by data		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
11.0 Operational Definitions			
11.1 Construct definitions on the basis of changes which occur or what an object does or how it is used	ID	DE	
11.2 Contrast an operational definition with a non-operational definition	I	DE	
11.3 Construct operational definitions	I	DE	
12.0 Designing an Experiment			
12.1 Recognize the manipulated and responding variables		ID	
12.2 Design, conduct and report an experiment using appropriate techniques		DE	
13.0 Formulating Models			
13.1 Identify similarities and differences in the models of two systems	ID	D	
13.2 Generate spatial models	ID	E	
13.3 Generate mathematical models		ID	

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APPENDIX "C" **SCIENCE PROCESSES DEVELOPMENT - PROBLEM SOLVING: K-9**

PROBLEM SOLVING	K-3	4-6	7-9
1.0 Apply appropriate questions when a problem is stated	I	ID	E
2.0 Transform information into a representation illustrating a solution		I	DE
3.0 Recognizing alternative factors affecting possible solutions and propose strategies for solution		I	D
4.0 Establish criteria for judging a solution		ID	E
5.0 Collect, analyze and synthesize relevant information		ID	DE
6.0 Identify alternate models or drawings to illustrate a solution to a problem		I	D
7.0 Recognize, and define a problem in a researchable format			ID

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APPENDIX "D"

OBJECTIVES AND CONCEPTS FOR SCIENCE-TECHNOLOGY AND SOCIETAL INTERACTIONS

CONCEPTS	PROGRAM OBJECTIVES
SCIENCE AND TECHNOLOGY	
- Science is the process of increasing and testing our knowledge of the natural world; enables us to predict the outcome of events in the natural world. - Technology is the process of using resources and scientific knowledge to develop products and/or processes which attempt to resolve problems and/or needs of society. - Science and technology advance one another. Technological processes are sometimes invented without knowledge of the scientific principle behind them.	The student will be able to: - Distinguish between science and technology. - Identify the principle(s) upon which simple technologies are based. - Identify examples of interdependence between science and technology.
NATURE OF TECHNOLOGY	
- Some technolgical devices and processes can be viewed as systems, or a series of simpler devices working as a system. - Technological processes and devices extend the abilities of humans and affect the environment. - A technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process.	- Identify the components of a functioning technological system including input, output, feedback and control. - Describe ways technological processes are related and extends the abilities of humans. - Explain why some processes become obsolete.

CONCEPTS	OBJECTIVES
INTERACTION OF SCIENCE, TECHNOLOGY AND SOCIETY	
- Changes in either science-technology or society has often affected the other.	- Demonstrate how science, technology and society are interrelated, it has improved the standard of living, imparted jobs and careers.
- Refinements in processes has resulted in new products to change lifestyles and industry.	- Describe that science and technology alone cannot solve society's problem.
- New industries may be created and others become obsolete, affect career choices, employment and education needs.	- Demonstrate that a technological process or device may be developed due to individual or societal needs and may be accepted or rejected because of societal attitudes.
- A technological process or device is usually developed in response to needs; however, sometimes the device is developed and the need created by marketing.	- Identify how technological advances have affected the interactions of nations.
- Technological advances have had global impacts.	
MAKING DECISIONS	
- Technological processes and devices offer increased choices. The purpose of a process and the choice made for its use determines its impact on society.	- Describe probable long and short-term consequences of a technological process or device.
- Decisions should be based on long and short-term consequences. Resolution of complex issues requires data from experts in many disciplines. Experts often disagree about solutions.	- To assess and accept or reject a particular technological process or device based on its advantages and disadvantages.
- Trade offs are sometimes made between the advantages and disadvantages for people and the environment. Some burdens are accepted because benefits outweigh them.	- Demonstrate some alternative solutions to technological issues.

CONCEPTS	OBJECTIVES
- A decision about a technological process or device leads to other questions and issues. Resolution of an issue may not be acceptable to all persons and groups.	
- Governments sometimes pass laws to regulate and control use of a technological process e.g. seat belts, nuclear power. Growth of science and technology is affected by public funding decisions.	Cite examples of legislation which has been passed to regulate a technological device.

APPENDIX "E" K-9 SCIENCE, TECHNOLOGY AND SOCIETY CONTENT

OBJECTIVES	K-3	4-6	7-9
Students will be able to:			
SCIENCE AND TECHNOLOGY DEFINED			
Distinguish between science and technology		I	D
Identify scientific principles upon which a simple technology is based		I	D
Identify examples of interdependence of science and technology			ID
Identify components of a functioning technological system with inputs, outputs, feedback, control		I	D
NATURE OF TECHNOLOGY			
Describe how technological processes or devices are related to one another		I	D
Explain how technology extends the abilities of human beings and affect the environment	I	D	D
Explain how and why a technological process or device becomes obsolete or is modified		I	D
Demonstrate how science, technology and science interrelate, has affected living standards and imparted on jobs or careers			ID
INTERACTION WITH SOCIETY			
Recognize that science and technology alone cannot solve society's problems			ID
Demonstrate that processes and devices are sometimes developed in response to needs	I	D	D
Demonstrate that certain processes or devices are not accepted because of societal attitudes			
Identify advances in technological processes and devices that result in nations interacting as communities such as acid rain, satellite television			ID
DECISIONS			
Describe probable long and short term consequences of a technological process or device - increased choices, advantages and disadvantages			ID
Assess a process or device based on short and long-term consequences			ID
Demonstrate that several solutions may exist to technolgical issues			ID
Cite examples in which legislation has been passed to regulate a process or device			

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APPENDIX "E"

USES OF COMPUTERS IN SCIENCE

1. Tools
2. Experimentation
3. Simulation
4. Computer Assisted Learning (CAL)

Definitions

Tools - software which assists teachers or students to manipulate or manage information. Examples include word processors, databases, spreadsheets, graphics-generation software, and teacher utilities.

Experimentation - computer hardware and/or software used for the collection and preparation of data for analysis. Using hardware input devices, measurements such as temperature, light intensity, PH, electric current, and time could be gathered directly by the computer.

Simulation - courseware which imitates a system (ecology, astronomy), a process, training (balances, oscilloscope, titration), or an experiment (for reasons of cost, hazard, duration, etc.), or courseware which provides abstract simulations from, say, chemistry or physics.

Computer Assisted Learning (CAL) - courseware whose main purpose is either to teach concepts or skills (tutorials) or for drill and practice.

Problem solving and the problem-solving process are acknowledged as an integral part of K-9 science and as such they are not identified separately in this discussion.

Computers are not a substitute for a well-balanced science program. However, computer courseware can enrich the science curriculum and if the courseware has been well developed it can help to make science instruction more effective. Teachers are encouraged to evaluate available courseware to determine its effectiveness prior to making a purchase.

APPENDIX "G"

SAFETY IN SCIENCE

The science program has been designed to stimulate interest in the students by performing many hands-on activities. Positive attitudes towards safety and the proper use of laboratory equipment must be developed in the students. The major causes of accidents are negative attitudes towards safety and carelessness.

Although the majority of the topics and activities are relatively safe, the onus is on the administration and the teacher to ensure safe laboratory experiences. A safe laboratory must have safety equipment and safety instruction as to the use of the equipment.

A complete list and description of safety equipment and safety procedures may be found in Safety in Science, Curriculum Support Series. The manual is available through Manitoba Education.

WOMEN IN SCIENCE

The role of the female in science has not kept pace with the expanding effect of science and technology on society. A concerted effort is needed by all educators to change the attitude of early adolescent females towards science and their roles in the scientific community. Educators must make a conscious effort to eliminate the unconscious bias that exists in classrooms towards women in science.

Guidelines for Addressing Sexual Bias in Classrooms

Teachers can:

- use inclusive, rather than exclusive, language.
- assure that textbooks, reference materials, films, videos, visual displays give equal consideration to both sexes in career and lifestyle portrayals.
- be aware that habit and tradition may result in different teacher expectations for girls than for boys and that the students own expectations may be reflected in their success rates. Both expectations may be communicated subtlety and may, therefore, be difficult to detect and correct.
- be aware that studies have shown that boys receive considerably more teacher feedback, occupy more physical space, are more critical of girls and of each other, and generally assume the leadership role in a mixed group. This has implications for almost every aspect of classroom management and methodology.
- question not just the content of a curriculum, which often ignores or gives little attention to women's contributions, but the context and definition of success or knowledge, which often predetermines that what is seen as male and what is seen as a contribution are synonyomous.
- encourage projects which recognize skills and interests of both sexes and discourage put-downers or devaluing of "female" interests--by male students.

APPENDIX "H"

SCIENCE FAIRS

A science fair is an exhibition of innovative activities, hands-on experiments and/or scientific research or literature reviews. The most important feature of the science fair is the work of each individual student. The fair is a method or mechanism to display the creative work of the student.

Some of the benefits of carrying out a science fair project include:

- the chance to express creativity and initiative in independent research;
- the experience of the excitement and frustration of scientific research;
- the opportunity to develop special skills in written communication, oral presentation and organization of work.

The work on a science fair project may be divided into three stages.

1. Preliminary planning and choosing of a topic.
2. Research or experimentation. Keep a daily log book.
3. Science fair project--the blackboard and display.

There are excellent publications, Science Fair Project Ideas, The Science Fair Rookie Kit and Handbook of Helpful Hints for Elementary Science Fairs, which are available to interested teachers. Refer to the annotations.

ANNOTATIONS

1. Science Fair Project Ideas--Youth Science Foundation, Suite 805, 151 Slater Street, Ottawa K1P 5H3.

2. The Science Fair Rookie Kit. MSSS. (Available through Manitoba Education and Training.)

3. Handbook of Helpful Hints for Elementary Science--T. Bilyk. (Available through Manitoba Education and Training.)

APPENDIX "I"

BASIC EQUIPMENT LIST

Grades 5 and 6

bar magnet
steel balls
paper clips
metre sticks
washers (different sizes)
spring balance (optional)
plastic pails
balloons
thread
string
paraffin wax
zinc sheets
copper
vinegar
lemon juice
compass
copper wire
steel wire
dry cell
6 volt batteries

sugar
sand
hand lens
microscope
modelling clay
candles
food colouring
bromthymal blue
alka seltzer tablets
yeast
rock samples
plaster of Paris
containers
birdseed
seeds (bean, chickpea)
pulleys
wheel and axle
screw nails
Lego or Mechano set (optional)
flashlight
globe
milk cartons
thermometer
barometer

APPENDIX "J"

Grades 7, 8 and 9

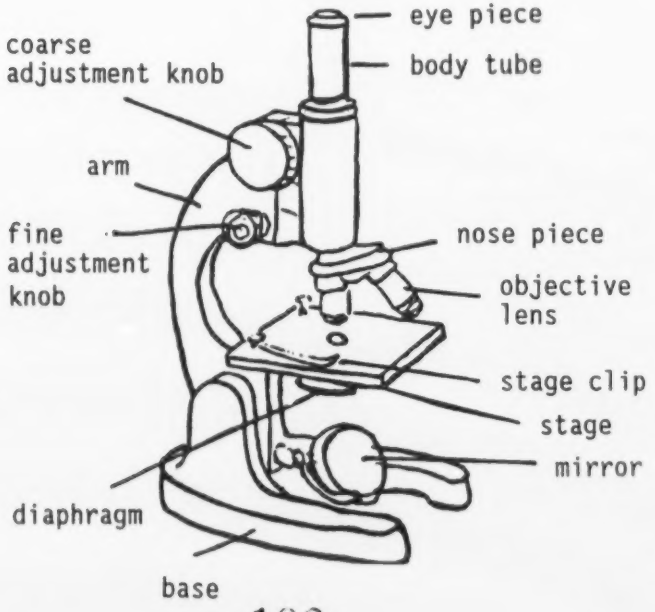
microscope
microscope slides, cover slips
hand lenses
yeast
thermometers
sugar
yo-yo
pendulum
light bulb
aquariums
flashlight
lens
glass prism
beakers
test tubes
variable size containers
protractor
drinking straws
tape
rubbing alcohol
food colouring
iron filings
mineral set
alum

spring scales
prepared slides of animal and plant cells
slides of blood cells
stop watch
paper clips
newsprint
fan
maps of Canada
map showing Continental Shelf
sand
soil
burners
ring stand
ring
clamps
bimetallic strip
bromothymal blue
litmus paper
pHydrion paper
household soaps, cleansers
shampoo
modelling clay
pulleys
protractor
spring scales
balance scale
gram weight set

APPENDIX "K"

THE MICROSCOPE

The microscope is an essential instrument in the study of living organisms because it enables the student to see things that are too small to be seen with the naked eye. The microscope the student uses in the science class is called a compound microscope because it has more than one lens. The part the student looks through is called the eyepiece and usually has a magnification power of 10X. This means that the object being viewed is enlarged ten times. The lenses attached to the nosepiece are called objective lenses. The number stamped on each lens indicates its magnification. For instance, if the eyepiece magnification is 10X, the total magnification of the microscope is (10X) x (10X) or 100 times.



These procedures should be followed when using the microscope:

1. Carry the microscope with both hands, one hand under the base, and the other on the arm.

2. Stand facing a light source and set the microscope on the table with the arm toward you.

3. Turn the objective lens with the smallest magnification until it clicks into place under the body tube.

4. While looking through the eyepiece, adjust the diaphragm and the mirror so that the greatest amount of light is coming through the opening in the stage.

5. Place the prepared slide on the stage. Centre the specimen over the opening in the stage and use the stage clips to hold the slide in place.

6. Always look at the microscope from the side as you are using the coarse adjustment knob to lower the body tube until it almost reaches the slide. This will prevent you from breaking the slide and/or damaging the lens.

7. Look through the eyepiece, observe the specimen and slowly raise the body tube until the specimen comes into focus.

8. Always view the specimen with both eyes open. This will prevent eyestrain and allows you to make sketches of your observation without losing sight of the specimen.

9. Make certain that the body tube is raised, before swinging the high-powered objective into place, so that the lens does not hit the slide.

10. Keep the microscope clean of dust, dirt and spilled fluids. Use lens paper for cleaning the lenses to avoid scratching them.

    To prepare a wet mount place the specimen in the middle of a clean microscope slide. (The specimen must be thin enough to allow light to pass through it).

Place a drop of water on the specimen (use a medicine dropper).

Place one side of a clean cover slip at the edge of the drop of water. Slowly lower the cover slip over the specimen and water. (This will prevent air bubbles from forming over the specimen).

RESPONSE QUESTIONNAIRE FOR K-9 SCIENCE PROGRAM OF STUDIES

Please return this questionnaire by January 15, 1992 to the:

Science Consultant
Curriculum Services
Manitoba Education and Training
411-1181 Portage Avenue
Winnipeg, Manitoba R3G 0T3

Please respond to each question in the space provided. (Attach extra sheets if more space is required). Use the page references when making specific comments.

1. Does the guide provide you with sufficient information as to nature and scope of the science program?

_____

_____

2. Are you able to adequately cover the stated objectives within the available class time?

_____

_____

3. Are your students capable of achieving the objectives listed in the unit(s)?

_____

_____

4. Is there sufficient variety in the activities to allow all students to take part in the program?

_____

5. Which activities are too simple or too difficult for the intended grade level?

_____

_____

6. Which activities do not seem to work well?

_____

_____

...../2

7. Which activities require clearer directions?

_____

_____

8. Are there sufficient material resources in your school to enable you to adequately teach the program?

_____

_____

9. Is there difficulty in obtaining science materials in order to carry out the activities?

_____

10. Do the students enjoy or appreciate the program?

_____

_____

11. What are some specific features of the program with which you are pleased?

_____

_____

12. Within the framework of the revised program, please make suggestions which, in your opinion, may result in significant improvements.

_____

_____

_____

_____

_____

NAME: _____ SCHOOL: _____

GRADE: _____ PHONE: _____

THANK YOU FOR YOUR ASSISTANCE.